review

ONE OF THE WORLD'S LONGEST
RUNNING TRADE JOURNALS

02|2022 en

ABB Ability™

Optimizing water management

Smart energy management

Supercharging battery production

ABB Ability™

Powerful connections

Buzzword Demystifier

Readership survey

What do you think?

We want to make sure that every issue of ABB Review is useful to you, so we'd like to ask you a few questions about your reading experience and expectations.

The survey should take no more than 10 minutes to complete and your feedback will be greatly appreciated.
Survey closes on 17th June.

https://global.abb/group/en/technology/abb-review/reader-survey

EDITORIAL

ABB Ability™

Dear Reader,

In October 2021, we marked the five-year anniversary of ABB Ability, the company's portfolio of digital solutions. This milestone serves as a great opportunity to take stock of the many innovations ABB has introduced around the industrial Internet of Things (IoT) and to examine some of the replicable ways our customers can apply these innovations to benefit both the bottom line and the planet. Our aim with this portfolio is to empower new, data-driven insights and billions of better decisions throughout industry, continuing to drive productivity and efficiency gains while helping to usher in a low-carbon society.

We are always striving to make ABB Review even more useful and relevant for you. Your opinion matters. I kindly ask you to give a few minutes of your time by taking part in the online readership survey on page 4 of this journal or on https://global.abb/group/en/technology/abb-review/reader-survey.

Enjoy your reading,

Björn Rosengren
Chief Executive Officer, ABB Group

ABB Ability™

Billions of better decisions

Giving customers better insights on their challenges and opportunities, better visibility into their operations, and better ideas based on deep and cross-industry experience empowers them to see things in new ways and make better decisions. Here are examples of ABB Ability™ working with customers to put those strategies into practice and deliver added value.

EMPOWERING BILLIONS OF BETTER DECISIONS WITH ABB ABILITY™

ABB Ability™

Insight is the power to see and understand causalities and possibilities in a new way. It extracts clarity from complexity and opens paths to action. ABB Ability™ transforms data into knowledge and delivers profitability, sustainability and safety to myriad industrial applications.

James Macaulay
ABB Corporate Communications
Vancouver, Canada

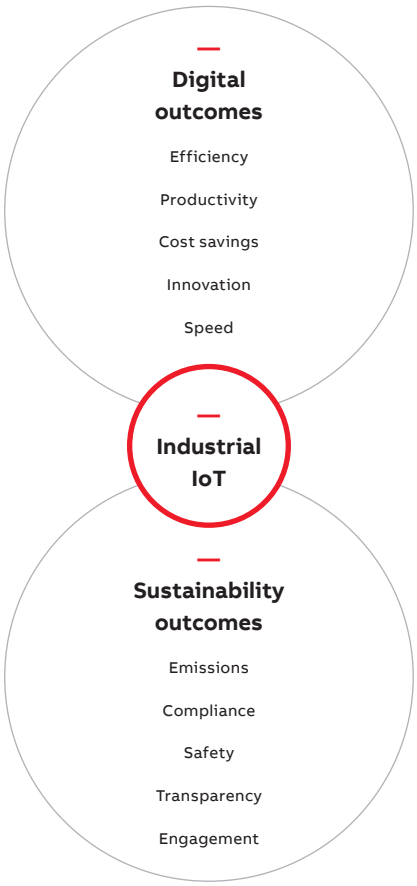
james.macaulay@ca.abb.com

With recent events upending untold business processes and organizational routines, and with continued disruptions to global supply chains, making wiser use of resources has become essential to industry's efforts at fostering operational resilience. At the same time, commercial and industrial organizations are coming under renewed pressure from a cross-section of stakeholders, including employees, customers, partners and regulators, to reduce greenhouse gas emissions and improve the sustainability of operations.

Making wiser use of resources and lowering carbon emissions requires making better decisions throughout industry, not just in a piecemeal fashion, but at scale. With industry being both the biggest consumer of resources and the largest source of emissions, to create material impacts on sustainability, every member of the industrial workforce needs to be engaged to find solutions and work smarter – in effect, making billions of better decisions.

Making wiser use of resources has become essential to industry's efforts at fostering operational resilience.

Recent research from ABB refers to better decisions at scale as "industrial transformation's new imperative." While it's often said that information



01

— 01 The Industrial IoT lies at the nexus of sustainability and digital outcomes.

technology (IT) and operations technology (OT) are converging, what we are witnessing today is another important convergence within industry, that of digitalization and sustainability. Fully 94 percent of some 800 global industrial decision-makers in ABB's survey agreed that these strategic priorities are "intrinsically linked."

The industrial Internet of Things (IoT) sits at this nexus →01. It represents a panoply of networks of connected physical assets, sensors, analytics, edge and cloud computing and other supporting technologies that can enable better decisions on how resources and energy are used throughout the enterprise.

That's where ABB Ability – the focus of this quarter's edition of ABB Review – comes in. ABB Ability is the company's holistic portfolio of digital solutions, which all have one thing in common: they empower commercial and industrial organizations to generate insights that allow them to make better decisions about their operations.

In these pages, we examine how ABB Ability solutions can help customers be more energy efficient, extend asset lifecycles, lower maintenance costs, increase productivity, boost safety and drive greater agility, supporting a host of key use cases falling under the umbrella of the industrial IoT. This quarter, we investigate an array of exciting applications in marine operations, energy management for commercial buildings, intelligent water management, the digitalization of mining and lots more.

The logic that underlies all ABB Ability solutions is that when we know more, we can do better. Companies need the right information, properly secured and contextualized, coupled with the right analytics, to arrive at and execute upon decisions that optimize operations. This depends on having the requisite domain expertise – on business processes, workflows, and the on-the-ground reality of operating a cement plant, a wastewater facility, a fleet of tugboats or a data center – to make sense of the avalanche of data firms produce. Through the industrial IoT, ABB Ability solutions combine the power of connectivity and domain-specific software algorithms that can help unlock value from operational data and drive big improvements in decision-making.

The logic that underlies all ABB Ability solutions is that when we know more, we can do better.

As is regularly showcased in ABB Review, the industrial IoT is having a profound, positive effect on operations in sectors ranging from manufacturing to energy, transportation and cities. Industry 4.0-driven gains in productivity, customer-centricity and agility are now well-documented. ABB Ability solutions, deployed by thousands of organizations around the globe, have played an important role in shaping the fourth industrial revolution. Now, they are shaping Industry 4.0's next incarnation, empowering better decisions that contribute to resource circularity, decarbonization and greater sustainability for all. •

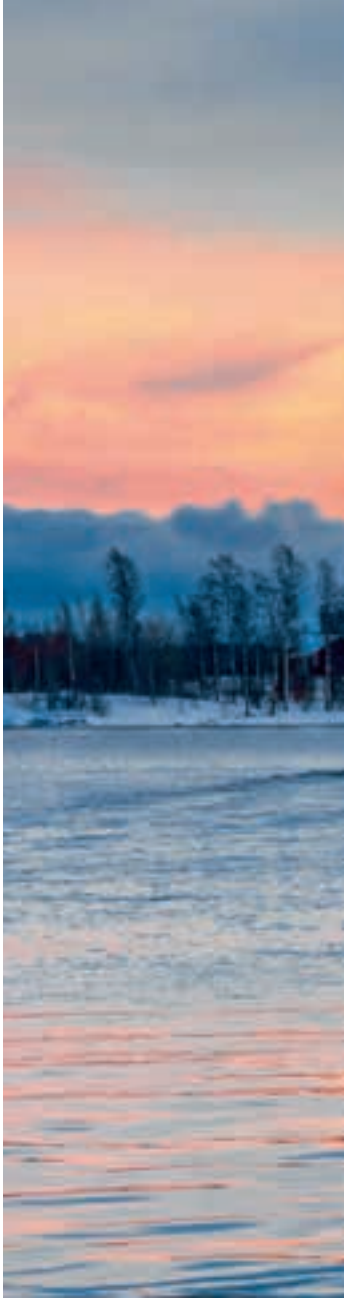
BETTER DECISIONS FOR MARINE OPERATIONS WITH ABB ABILITY™ MARINE PILOT PRODUCT FAMILY

Navigating the future

By complementing human strengths, ABB's Marine Pilot solutions offer seafarers better situational awareness, easier, safer and more efficient operations and predictable, consistent control.

Kalevi Tervo
ABB Marine & Ports
Helsinki, Finland

kalevi.tervo@fi.abb.com



01

Despite introduction of advanced navigational technologies, oceangoing vessel navigation still relies heavily on human perception. People are excellent at handling uncertainty: They solve problems with creativity, applying their knowledge and experience in making judgements, however human senses and capabilities are suboptimal for many situations faced at sea [1-2].

As a global leader in advanced digital and automation technology supporting the shipping industry to achieve safe and efficient operation, ABB posed the question: How can recent developments in sensor technology, data analytics and computing power be used to provide seafarers with better situational awareness and improved vessel control?

Human senses and capabilities are suboptimal for many situations faced at sea.

ABB's answer is to introduce digital, autonomous and remote control capabilities to enable machines and humans to work together for superior performance. By using autonomous technologies crew can be freed for supervisory tasks, or to tend to alarms or navigation notifications, anything that might arise – all working together to ensure optimal performance, whether during a long ocean transit or docking at a harbor.

ABB Ability™ Marine Pilot family of smart products: ABB Ability™ Marine Pilot Control and ABB Ability™ Marine Pilot Vision, have been developed to support seafarers in achieving safer, more efficient, consistent and predictable navigation and operation →01.

The bridge is the stage

Despite the availability of mandatory navigational aids such as radar, global navigation satellite systems (GNSS), Automatic Identification System (AIS), Gyro compass and Electronic Chart Display System (ECDIS) on the bridge, navigation is still heavily reliant on human senses [1-2].

People known as a lookouts peer out the bridge windows, perhaps with binoculars – 400 year old technology – to make observations. This information is relayed to the officer of the watch (OOW), who combines it with information

—
01 In 2018, ABB successfully trialed the ABB Ability™ Marine Pilot products on the Suomenlinna II, a passenger ferry (shown here), in Helsinki harbor.

delivered independently by navigational tools and domain knowledge to form a “mental image” and assess the situational risk (based on relationships between different inputs and information reliability).

—

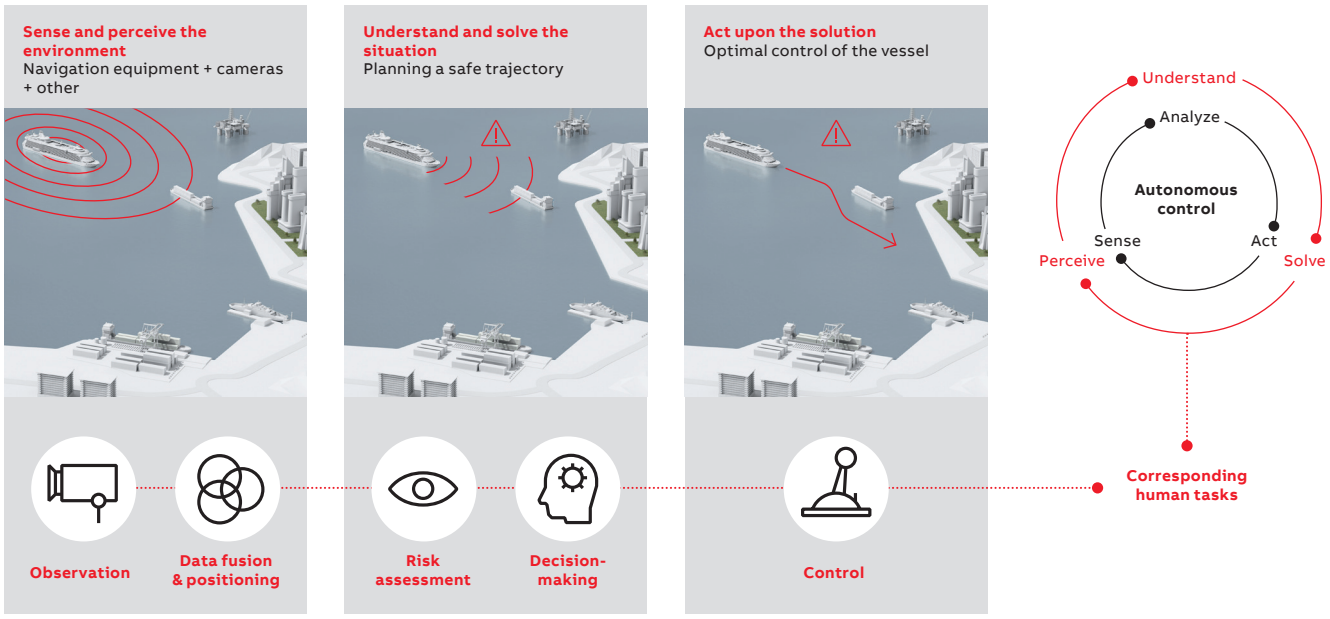
Today’s navigation systems rely heavily on human perception, understanding and interpretation of information.

Risk can then be mitigated by, for example, adjusting the ship’s speed to ensure safe and efficient operation. Today’s systems rely on human perception, understanding and interpretation of information etc, and such dependence is challenging [1-5] →02. For example, the navigational aids might not detect small objects, or those that do not reflect radar frequency. If the lookout does not see these objects, for all practical purposes they do not exist.

Another challenge is the independence of navigational devices onboard that supply independent data points. While this siloed information prevents single-point-of-failure, it results in unnecessary duplication and complexity for the crew, who must observe, process and utilize the information manually.

The human factor

Human senses are suboptimal for slow, continuous or wide-angle observations; this combined with subjective manual observations, human-to-human communication and intermittent flow of information, can increase the risk of missing an



02

event or a conflicted understanding of challenging situations, common at sea.

For instance, restricted bridge visibility [2,5] requires additional crew during docking and tug operations; the crew relies on subjective data about size and distance of obstacles, manually, eg, via walkie talkie, to the bridge. Adverse weather, fog and darkness can impair vison and concentration while a ship's motion can interfere with the crew's ability to detect situational changes, eg, an approaching vessel.

Monotonous situations, for example, a calm, sunny day at sea with "nothing" on the radar, are also challenging. Boredom and dwindling focus can result in a situation where a slowly developing event is not recognized, leading to a near miss on a virtually empty sea even under favorable conditions. Such situations challenge the crew's ability to observe, combine, and process information, and to act appropriately.

More autonomy

Autonomous solutions exist today that can support crew in ways that were previously impossible. Objective, accurate, repeatable, continuous, durable, and with improved system redundancy; with the right sensors, autonomous systems can perform observations and initiate consistent and predictable control operations to minimize risks in any situation.

Designed to sense and perceive the environment, ABB's Marine Pilot products further understanding, and solutions for any situation →02–03, thereby enabling a safe trajectory and optimal control of the ship [1,3-4] →02. The operator is provided with a complete situational overview, novel awareness →04a and enhanced predictive control →04c for safer, more efficient operations – a real boon to seafarers.

Imagine a ship crossing the open ocean; the OOW can easily spend their entire shift watching, viewing radar screens, without needing to touch any equipment. The monotony can lead to mental and physical fatigue; and reduced alertness, so that when critical tasks must be performed, eg, approaching heavily trafficked regions, reaction times may become too slow [3-5]. By automating observations, combining data, risk assessment and decision-making, the crew could rest, or review mission goals, increasing alertness for the critical work ahead. The OOW could use their expertise when required [4].

Designed to sense and perceive the environment, ABB's Marine Pilot product solutions support humans for any situation.

By supporting humans – complementing their strengths – ABB's Marine Pilot products perform tasks beyond the comfort zone of crew onboard; humans can save energy and focus on their

—
02 The diagram illustrates how autonomous control of vessels works and correlates these to the equivalent human tasks – the current standard.

—
03 The structural and cognitive basis of the Marine Pilot approach.

03a The building blocks of the Marine Pilot Family with important modules.

03b A comparison of data flow associated with higher level human cognitive capabilities of bridge operations with those of the Marine Pilot approach that allows situational understanding even if the responsible human fails.

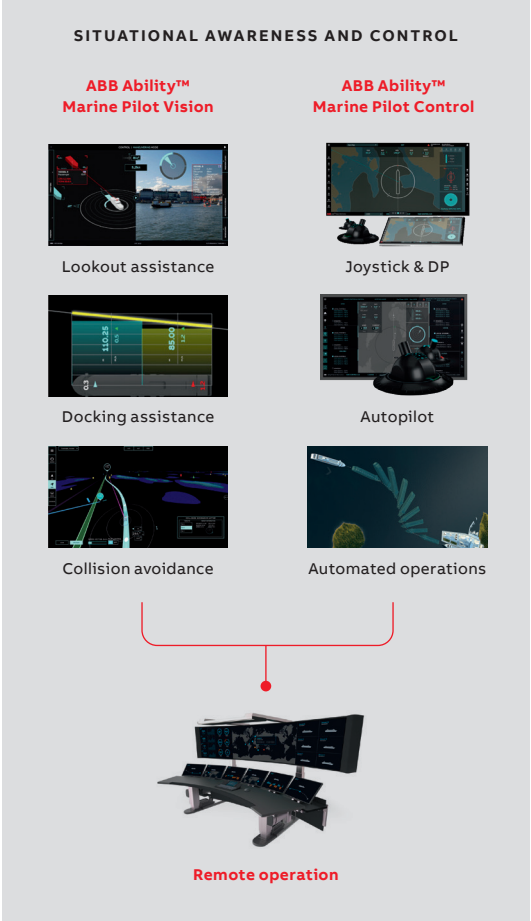
strengths, eg, judgment. The resulting collaboration – a human-machine team improves safety and efficiency, facilitating new ways to operate.

Perceptive Visions
Relying on navigational aids and visual perceptions, the crew determines the position and motion of the vessel. While a robust and fault-tolerant assessment is possible even if one input, eg, GPS, provides inconsistent data, the process

—

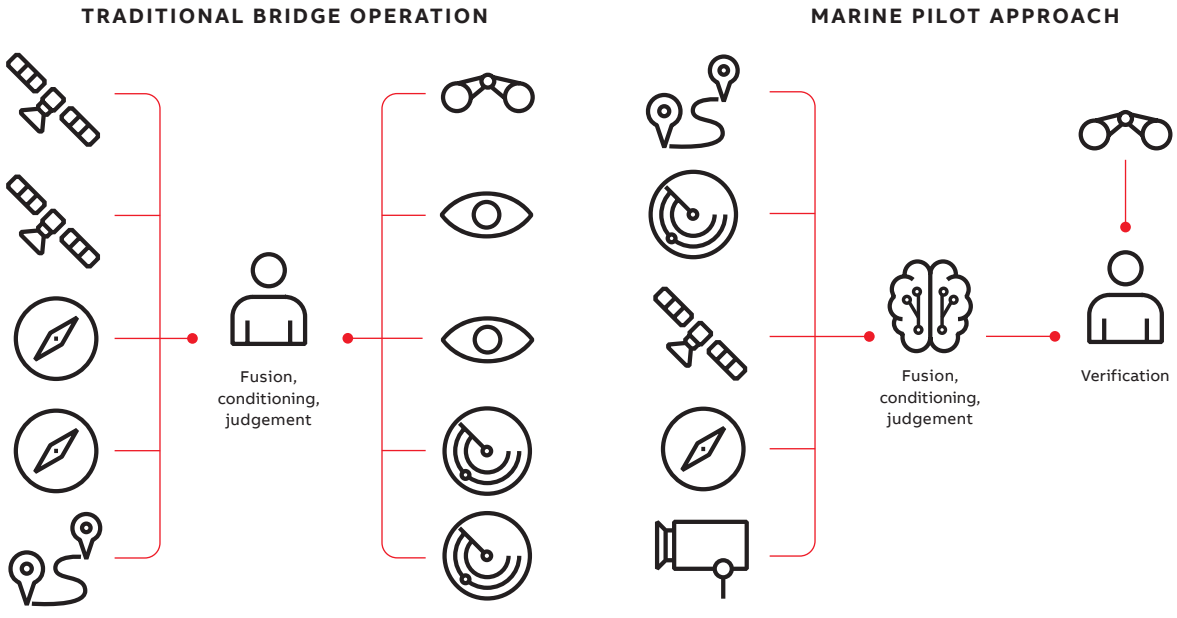
By using autonomous technologies crew can be freed to supervise, tend to alarms or navigation.

is prone to human error. Marine Pilot Vision enables situational assessment by providing data fusion and information processing capabilities automatically, without relying solely on human performance – crucial for demanding operations. Designed as modules to support operational situations that rely heavily on human perception, Marine Pilot Vision includes: Docking Assistance, Lookout Assistance and Collision Avoidance →02–03.

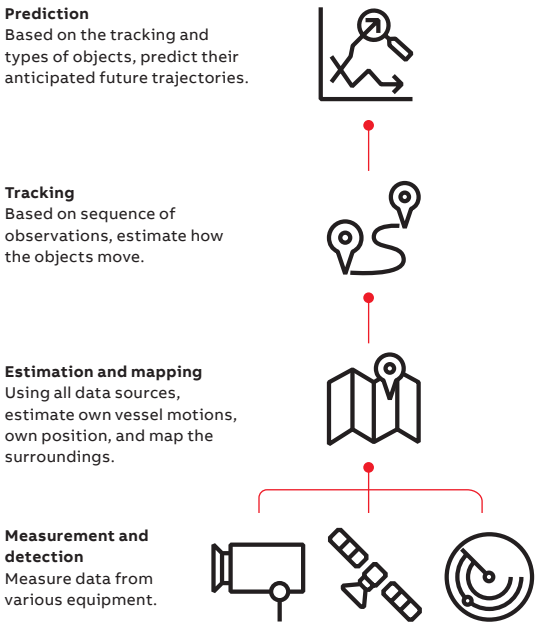


03a

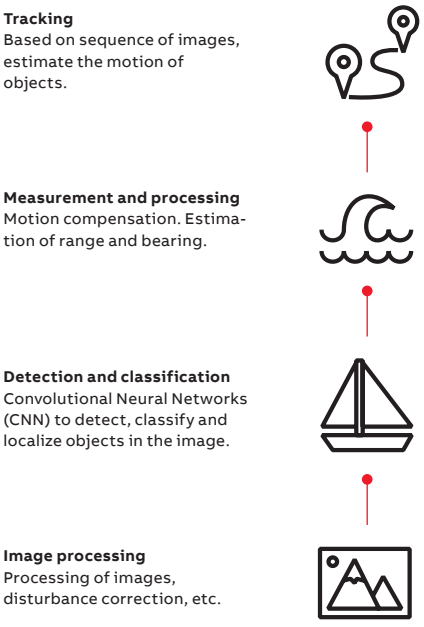
Docking Assistance
Docking Assistance is ideal for close-range operations eg, port maneuvering that typically requires several deck crews to estimate clearances, distance and alignment to the quay. Automatic close-range monitoring in real-time uses fused data from multiple sensors; evaluating the actual vessel position, alignment to quay and vicinity, without relying on GPS, eg, in coastal environments and port areas where satellite-based positioning is prone to jamming.



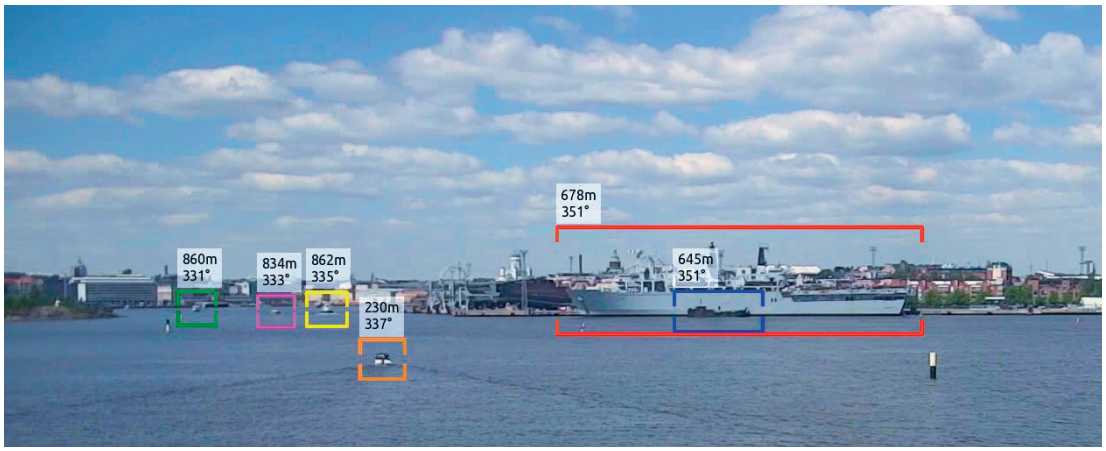
03b



04a



04b



04c

Lookout Assistance
Emulating the human lookout, the Lookout Assistant performs visual monitoring automatically, continuously, relentlessly, objectively, and at a wide- or full-angle →04 [3].

Utilizing convolutional neural networks (CNN), trained specifically to detect and classify marine-relevant objects, the Lookout Assistant analyzes incoming video streams in real time; processes frames (correcting for disturbances, eg, lens effects), locates multiple objects and assigns detection confidence values. Because relative range and bearing to each detected object is based on camera[1] data, collision avoidance is enabled for objects typically missed by navigational radars, such as small boats, etc. →04.

Collision Avoidance
Oceangoing vessel transits typically use a preplanned route, charted in ECDIS, etc., that is executed via autopilot, to ensure safe operations. Despite this, confounding situations occur, eg, loss of attention or accidents. In such situations, collision avoidance will mitigate the actual situational risk.

What if multiple vessels are encountered in a space-limited environment →05? Currently, risk assessment, decision-making and avoidance-maneuver planning is manual, and therefore prone to human error. The Collision Avoidance module resolves these challenges by performing these processes automatically, continuously, and objectively →06.

Footnotes:
[1]Safety of Life at Sea (SOLAS) requirements can also be fulfilled as the forward-looking camera field of view can be extended by adding more cameras.

[2]COLREGS stands for the Convention on the International Regulations for Preventing Collisions at Sea; it was adopted in 1972 and entered force on July 15, 1977.

05

—
04 Diagrams that illustrate situational awareness and the Marine Pilot Lookout assistance data flow and computer vision technology.

04a The main tasks of situational awareness are to determine the accurate position of the vessel in relative or global coordinates, determine what type of objects are nearby and their position; estimate the 6D motion and movement of the vessel and other objects accurately.

04b An illustration of the data flow for the Lookout Assistant Module of the Marine Pilot Vision. It enables automatic detection, tracking and estimation of the range and bearing of obstacles based on visual observations.

04c Computer vision-based detection, tracking and measurement technology in Marine Pilot Vision Lookout module.

—
05 In 2021, ABB and Keppel Offshore & Marine successfully tested the autonomous and remote control of a tugboat from a land-based command center in Singapore.

The system considers all vessels along the planned route, evaluating risk and calculating a safe plan. Fused data from sources, fairway space based on ENC, and COLREGs rules are used to plan the avoidance maneuver – a safe and efficient trajectory is calculated, course and/or speed are adjusted →06. Distances are configurable and adjustable based on multiple criteria; different behaviors are programmed based on various targets, navigational statuses, etc. for exceptional situations and local variations in the COLREGs rules.

The ultimate advisory system for the crew to assist in safe navigation for any type of vessel, this module with Pilot Control, enables autonomous collision avoidance actions.

Gaining control

Despite their prevalence, autopilot and dynamic positioning (DP) are two separate navigation and maneuvering control systems with contrasting utility. Developed for controlling course, heading and forward speed during open sea transits, autopilot assumes smooth operation and slowly changing conditions: it is insufficient for precise control and maneuvering operations in tight fairways or ports. In contrast, DP systems, designed with a zero-speed assumption, are ideal for low speed-maneuvering or maintaining a position automatically [6]. At low speeds, ship and thruster hydrodynamic models are simplified: speed-dependent phenomena, eg, nonlinear damping or rudder and drag effects of thrusters are neglected – Linear Quadratic optimal control solutions are common. Hence, DP systems are not suitable for dynamic maneuvering control situations performed at speed.

—

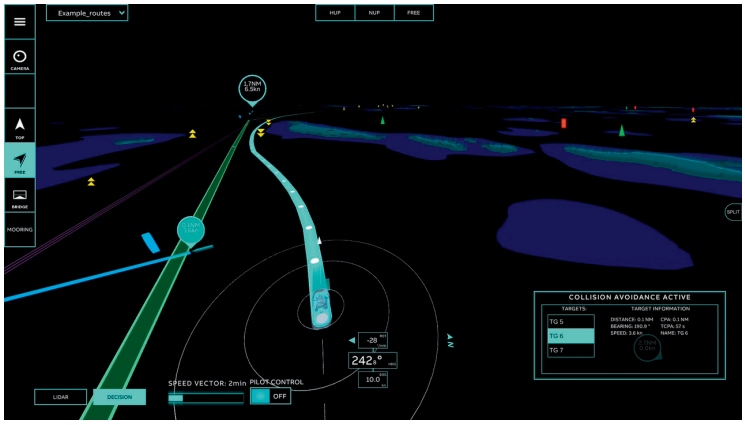
With a single control system for the entire voyage, Marine Pilot Control mimics the control behavior of experienced captains.

ABB's Marine Pilot Control approach allows the use of the same control system throughout the journey. By relaxing the zero-speed assumption of a traditional DP system, a consideration of the speed-dependent hydrodynamic effects in the control actions is possible – important for Azipod® propulsion. Although complex, the resultant nonlinear model predictive control (MPC) algorithms enable automatic control of the vessel at zero speed, maneuvering at speed, or transit in open waters [6].

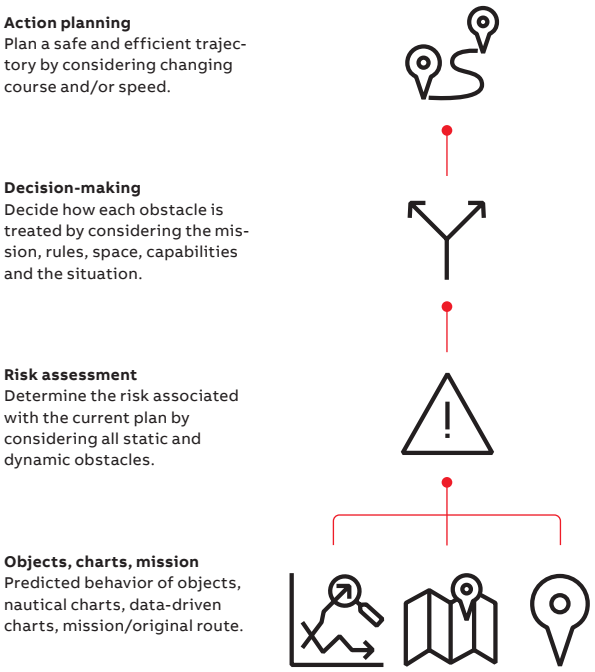
By providing the crew with a single control system for the entire voyage, Marine Pilot Control mimics the control behavior of experienced captains who utilize the vessel speed, rudder effect of the thrusters, and dynamic operational conditions to their advantage.

Moreover, events can be anticipated – critical for matching human performance. If a captain knows (s)he will stop or turn the vessel soon, (s)he will adjust the thrusters beforehand to a direction where the required force is anticipated. Marine Pilot Control's nonlinear model predictive control algorithms enable this capability. The result is faster and more precise control in dynamic operations, eg, port maneuvering, docking; and accurate trajectory in restricted spaces.

Marine Pilot Control also features all-speed joystick control, and automated operations, eg,



06a



06b

docking, transit, voyage, and crash-stop. The result is increased consistency and operational predictability – better schedule-keeping and decreased fuel consumption →07 [7].

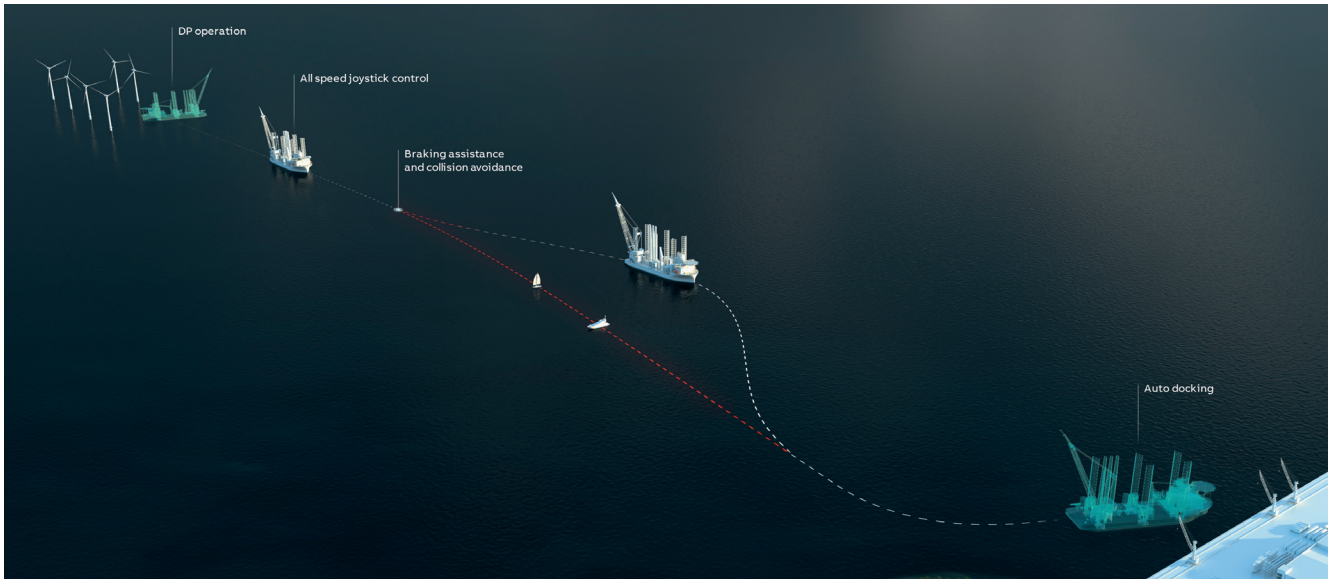
Enabled as a class-approved DP system for offshore vessels with DP2 requirements, Pilot Control's automatic operations can be upgraded to autonomous if deployed with Pilot Vision

ABB and Keppel Offshore & Marine successfully tested the autonomous and remote control of a tug in the harbor of Singapore.

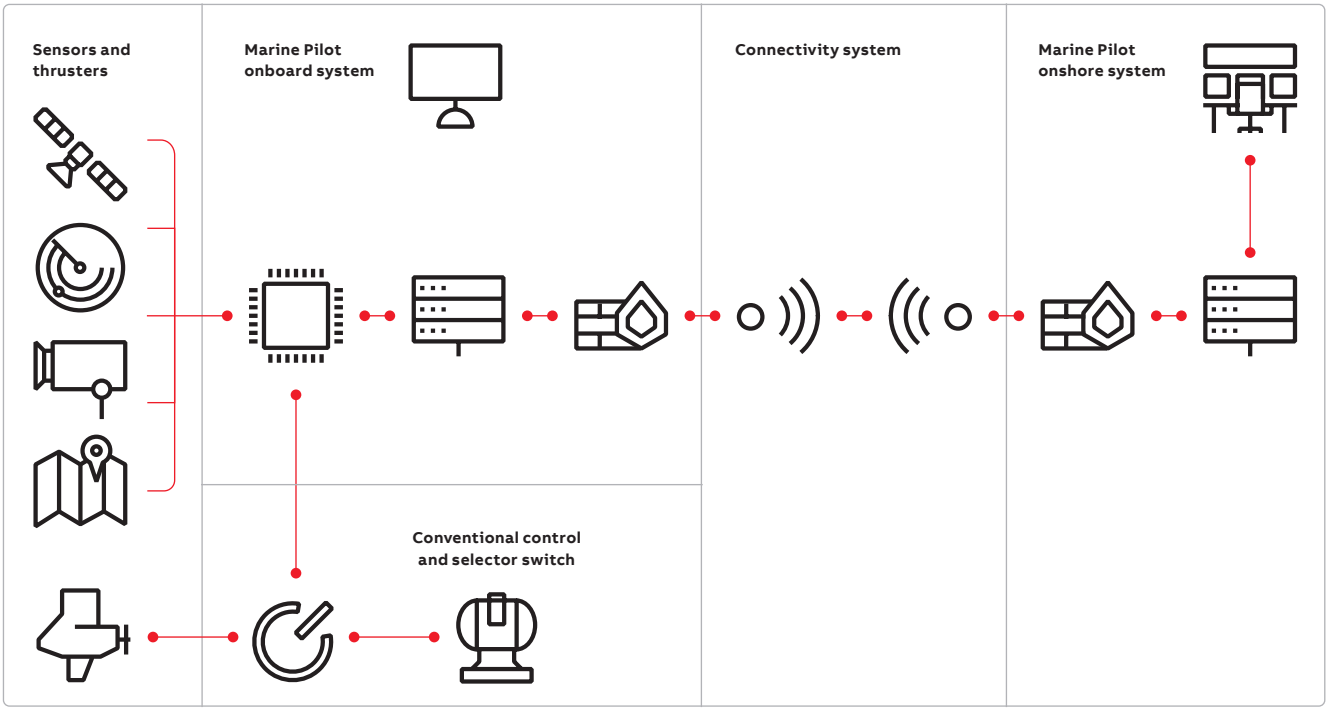
and Collision Avoidance, thereby facilitating the ability to react to changing surroundings and dynamic situations while the crew is being informed of anticipated situations and planned actions →07.

Autonomous and remote-controlled tug operation

To evaluate increased safety of Pilot Control's fault-tolerant design and joystick control for maneuvering around a berth [4], ABB and Keppel Offshore & Marine successfully tested the autonomous and remote control of a tug in the congested harbor of Singapore in 2021 →08 [4,7]. Marine Pilot Vision created a virtual view of the tug's location relative to obstacles by integrating navigational data, streamed to the onshore command center, where the operator received



07



08

—
06 The Collision Avoidance module data flow schematic and example.

06a A screenshot of the autonomous Collision Avoidance module in action. A safe trajectory is ensured because the crew is presented with highlighted targets and estimated encountering points, via the Marine Pilot interface.

06b The diagram illustrates data flow for the Collision Avoidance module. The system runs in 1 Hz frequency considering the future situation in a parametrizable horizon (eg, 30 min ahead). If the target is encountered within a configurable time window (eg, 15 min), with high enough probability, less than a configured risk threshold, then the system considers an avoidance maneuver.

—
07 An illustration of situations in which Marine Pilot products can be effectively utilized.

—
08 A conceptually simplified diagram of the autonomous and remote control system implementation with a selector switch to return the control to conventional local control.

the augmented situational awareness →04a, 06 [4,7] while successfully controlling the vessel, autonomously; Collision Avoidance tests are currently underway. Because Pilot Control follows a single-point fault tolerant principle, the risk of failure is mitigated. Such real-world tests are crucial because any autonomous ships will need to operate safely around real ships, buoys, etc, not in artificially quiet zones.

Future waves

All mariners will benefit from innovations like ABB's Marine Pilot solutions providing better situational awareness, easier, safer and more efficient operations and predictable consistent control [4,7]. Once deployed, software updates can enable autonomous and remote functions later as regulations evolve [1]. Although an unattended bridge on an ocean-going vessel might be elusive today [5], ABB sets the stage for this future reality by developing products that meet real-world conditions for autonomous navigation. •

Marine Pilot solutions provide situational awareness, easier, safer and more efficient operations and predictable control.

Footnote:
[1]SOLAS requirements can also be fulfilled as the forward-looking camera field of view can be extended by adding more cameras.

—
References

[1] ABB round table news, "The digital journey to autonomy: taking smarter steps", *Generations: ABB marine & ports*, Singapore, April 26, 2021, Available: https://new.abb.com/news/detail/77389/the-digital-journey-to-autonomy-taking-smarter-steps [Accessed March 29, 2022].

[2] Press release, "ABB Puts Forward Guiding Hand For Autonomous Shipping; Awaits Required Regulations", *Marine Salvage News*, June 11, 2020, Available: https://marine-salvage.net/en/maritime-news/abb-puts-forward-guiding-hand-for-autonomous-shipping-awaits-required-regulations/ [Accessed March 29, 2022].

[3] K. Tervo and E. Lehtovaara, "Electronic lookout for increased ship safety", ABB Web story, Helsinki, Finland, February, 22, 2021, Available: https://new.abb.com/news/detail/74475/electronic-lookout-for-increased-ship-safety [Accessed March 29, 2022].

[4] K. Tervo, "Tug project: putting ideas into action" in International Tug & OSV, January/February, 2020, pp. 26–27.

[5] K. Tervo and E. Lehtovaara, "B0 – a conditionally and periodically unmanned bridge", in *ABB Generations: Marines & Ports*, Available: https://new.abb.com/news/detail/24651/b0-a-conditionally-and-periodically-unmanned-bridge [Accessed March 29, 2022].

[6] A. BÄRLUND, et al., "Nonlinear MPC for combined motion control and thrust allocation of ships" in *21st IFAC World Congress Special issue*, Vol. 53, Issue 2, Ed., R. Findeisen et al., Berlin, Germany, July 11-12, 2020, pp. 14698–14703. [Accessed March 29, 2022].

[7] Innovation highlight, "Autonomous and remote-controlled vessel operation with ABB Ability Marine Pilot", *ABB Review* 1/2022, pp. 13.

01

BETTER DECISIONS IN ELECTRIC TUGBOAT POWER

Pulling ahead

In a collaboration with the Crowley Maritime Corporation, ABB is supplying the electrification technology to power the first all-electric tugboat in the United States. Crowley's eWolf tug for the Port of San Diego is a zero-emission workboat that takes an important step toward a sustainable future →01.

Dave Lee
ABB Inc.
Marine & Ports
Miramar, FL,
United States

david.lee@us.abb.com

Priscila Faester
ABB Inc.
Marine & Ports
Miramar, FL,
United States

priscila.faester@
us.abb.com

02

Photo fig. 02 ©SeanPavonePhoto/stock.adobe.com

—
01 ABB is supplying the entire electric propulsion system for Crowley's all-electric tugboat, the first of its kind in the United States.

—
02 The high number of vessel movements at the Port of San Diego gives it sufficient critical mass to introduce all-electric solutions.

Although shipping accounts for just 2 to 3 percent of annual global CO_2 emissions [1], this percentage could rise dramatically as other emitters decarbonize. The shipping industry is exploring ways to reduce emissions – primarily by replacing marine diesel engines with electric motors powered by efficient, high-performance and compact batteries, such as those found in electric vehicles.

Whereas many diesel-engined vessels spend much time at sea, far from land, one class of marine craft operates a busy trade exclusively around ports and, therefore, close to highly populated areas: the tugboat.

The Port of San Diego and the eWolf

The important role that tugboats play is often overshadowed by the presence of their more spectacular sisters – such as vast Panamax container ships. However, such ships are completely reliant on the assistance of tugboats to maneuver safely into and out of ports. In busy terminals such as the Port of San Diego, tugboats can be active day and night, which raises noise and emissions issues. For these and many other reasons, tugboats are ideal candidates for a move to electrical propulsion.

In California, the Port of San Diego is at the forefront of the transition from diesel to electric propulsion for workboats →02. The port authorities see the many advantages of battery-powered vessels – not only do they virtually eradicate emissions but they also make the local environment cleaner and quieter for residents. Working conditions are improved for the crew, too and vibrations are all but eliminated. Marine noise pollution is also substantially reduced, benefiting the sea life for which this part of the world is famous.

The first electric vessel to ply its trade for the Port of San Diego will be a tugboat, named eWolf, due for delivery in mid 2023 →03. Built by Alabama-based shipbuilder Master Boat Builders, Inc. for Crowley, the eWolf will be the first all-electric, battery-powered harbor tug ever built and operated in the United States and only the third of its kind to enter operations worldwide.

—
The port authorities see the many advantages of battery-powered vessels.

ABB has provided electric systems on board vessels for more than 110 years. Today, well

over 1,300 ships employ ABB's electric systems. Leveraging the company's long experience in marine electrical engineering and propulsion, ABB has worked with Crowley, Master Boat Builders and the Port of San Diego to supply

The eWolf's batteries provide power to the propulsion system almost instantaneously.

the electrical infrastructure that comprises the backbone of the eWolf's propulsion as well as its many ancillary electrical systems →04. Crowley is an excellent engineering partner as, with over a century of harbor workboat operations and over 60 years of vessel design experience, they have become widely known as a pioneer in the sustainable workboat space.

A sustainable design
The eWolf project presented the opportunity to design the vessel from scratch, which meant sustainable technology and design features that are also efficient and safe for operators could be prioritized. These innovative solutions involve many aspects of the overall design, from the pilothouse to the bulwarks.

Emissions goals for the project call for the operation of the new tug to eliminate 170 tons of nitrogen oxides (NO_x), 2 tons of diesel particulate matter, and 3,100 tons of carbon dioxide compared with a conventional tug over the first 10 years of operations.

A DC grid on the boat
ABB's Onboard DC Grid™ is the backbone of the enabling power technology for the eWolf, allowing the integration of batteries into these smaller but more active workboats →05. Onboard DC Grid is a modular power system platform that enables simple, flexible and functional integration of energy sources and loads, thus streamlining the design and build of power systems on all sizes of vessels. The platform is highly customizable so is easy to configure for the eWolf.

ABB Ability™ Marine Pilot family
Systems on board will also feature products from the ABB Ability Marine Pilot family for enhancing crew safety and reducing workload. For instance, ABB Ability Marine Pilot Vision provides an augmented view of the vessel's surroundings by combining information from a range of sensors, resulting in enhanced situational awareness for the operator →06. This situational awareness solution will provide 360-degree visibility from the pilot's station.

A second family member, ABB Ability Marine Pilot Control,will enable maneuvering support and future remote operations →07.

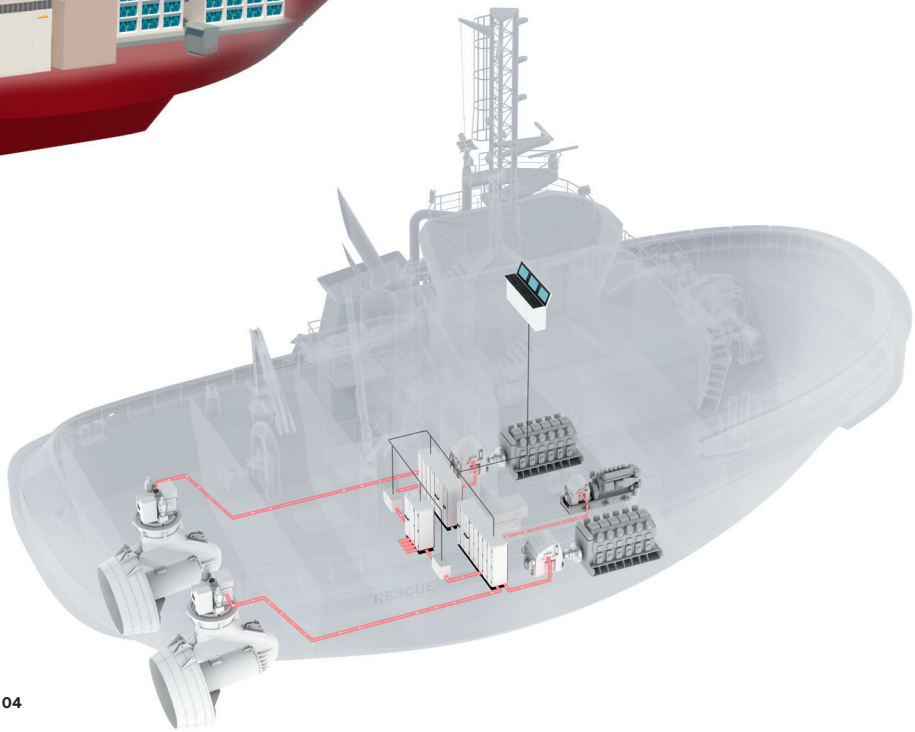
Marine Pilot Control is a new way to control vessels during all operational modes, including maneuvering, transit and position-keeping. Designed for autonomous and remote operations, the system enables optimal and complete all-speed vessel control from one operator position. Features include the potential to use the thruster control levers also as joysticks with ABB's proprietary AX3 levers.

ABB Ability Marine Pilot Vision and ABB Ability Marine Pilot Control also ready the vessel for future remote control operations. ABB has experience of this mode of operation from similar projects in Asia Pacific and Europe, including delivery of highly automated, remote control-ready harbor tugs to the Port of Singapore [2]. Increased levels of automation aid efficiency but also improve safety, which is of paramount importance.

The full scope of supply also includes propulsion motors, low-voltage switchboards, transformers, lithium-ion batteries, mechanical L-drive thrusters and the ABB Ability Remote Diagnostics System for Marine for continuous equipment monitoring and predictive maintenance.

Energy storage system
Tug operations can be demanding and often need to adapt to fast-changing load requirements. The eWolf's batteries provide power to the propulsion system almost instantaneously, making ship-assist operations more efficient and eliminating the extra emissions resulting from sudden power demands in diesel motors. Based on a typical workday, the batteries need fast charging during the day and less intensive overnight charging.

03

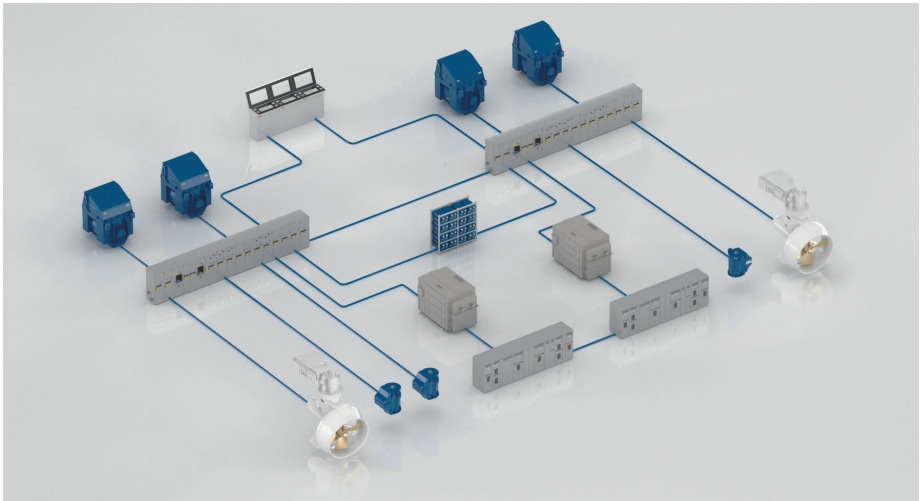


04

—
03 The eWolf.

—
04 Example of electrical propulsion and ancillary systems.

—
05 ABB's Onboard DC Grid.



05

06

07

—
06 eWolf vessel operations will be aided by ABB Ability Marine Pilot Vision.

—
07 ABB Ability Marine Pilot Control.

—
08 Ports around the world will be watching the introduction of the eWolf with a view to upgrading their own tugboats.

—
Reference

[1] International Transport Forum, "Reducing Shipping Greenhouse Gas Emissions." Available: https://www.itf-oecd.org/sites/default/files/docs/reducing-shipping-greenhouse-gas-emissions.pdf [Accessed: 29 March 2022.]

[2] "Autonomous controlled vessel operation with ABB Ability Marine Pilot," *ABB Review* 1/2022, p. 13.

The eWolf is being equipped with a 6.2 MWh Corvus Orca Energy battery – an essential part of the integrated electrical propulsion system delivered by ABB. Corvus Energy USA will supply this energy storage system and enable the eWolf to achieve around 63 metric tons of bollard pull, emissions-free.

Ergonomics and safety

The electrification concept also contributes to safety on board. For example, because the electric drive eliminates the traditional exhaust system, the captain has a 360-degree panorama from the pilothouse and an uninterrupted view of deck activity.

Pulling ahead

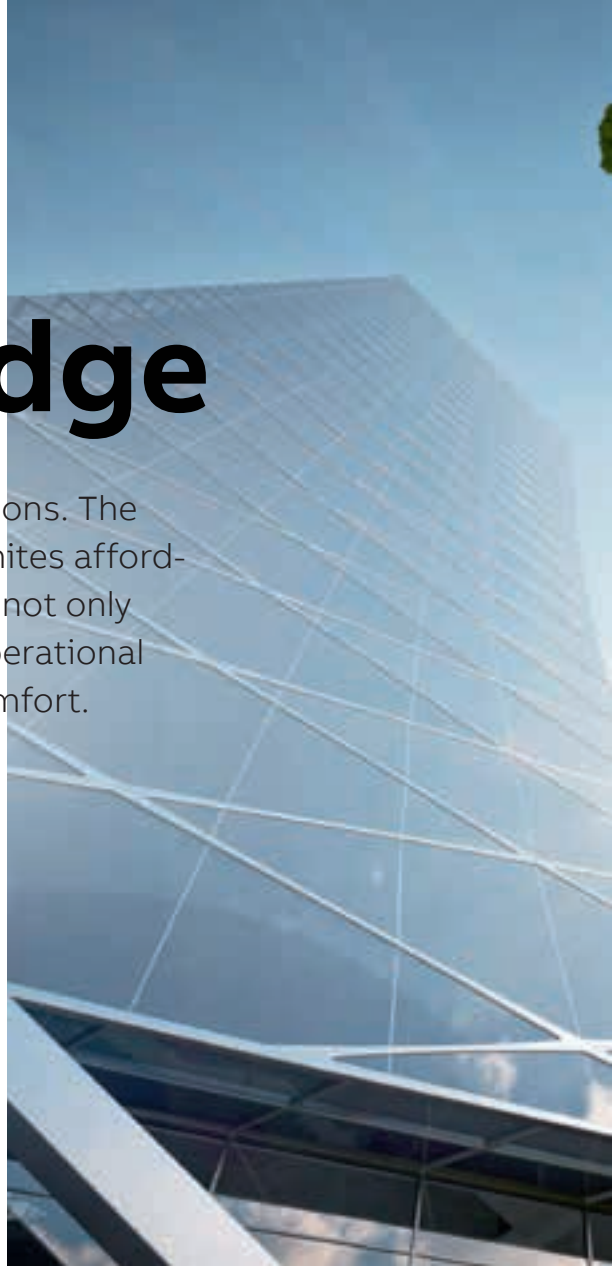
The introduction of the eWolf to the Port of San Diego will be a significant milestone in the diesel-to-electric transition of marine propulsion. The advantages of electric tugboats are numerous and it is expected that many other ports in the United States – and around the world – will be watching the introduction of the eWolf keenly, eager to upgrade their own tugboat fleets. The last word can be left to Vice President of Maritime at the Port of San Diego, Michael LaFleur: "San Diego is proud of our focus on blue and green technology. Our goal is to be a 'Port of Firsts.' Everyone is interested in what we are doing to bring about the transition from diesel to electric workboats, and this project allows them to see the tangible results, clearly demonstrating the advantages of the push to electrification." •

—
The introduction of the eWolf is a significant milestone in the diesel-to-electric transition of marine propulsion.

BETTER DECISIONS FOR SMART BUILDINGS

Inside knowledge

Buildings contribute significantly to global CO_2 emissions. The award-winning [1] ABB Ability™ Building Ecosystem unites affordable, intuitive software and open-system hardware to not only reduce energy usage and emissions but also to cut operational costs and optimize space utilization and occupant comfort.



01

When the road to net zero and CO_2 emissions are discussed, attention usually turns to transportation and industry. It comes as a surprise, then, to discover that buildings generate around 40 percent of the world's annual CO_2 emissions. Globally, construction and materials account for a quarter of this total, while building operations make up the rest [2]. In the United States, buildings consume 41 percent of the nation's total energy use through lighting, heating, air conditioning, elevators and the numerous items plugged into sockets [3].

Buildings are made to last, so most of those around today will still be here in a few decades. Whereas measures can be taken to reduce embodied carbon in future construction, little can be done about the embodied carbon in existing buildings. However, where the lion's share of emissions originates – in building operations – there is plenty that can be done. Here, the smart building is the key to understanding how and where emissions originate and how systems and behavior have to be adjusted to improve the building's environmental footprint. A smart building can not only reduce emissions but also cut operational costs and optimize space utilization and occupant comfort.

> Operations can be tailored for occupant comfort and convenience, which drives well-being and productivity.

Bertrand Vandewiele
ABB Smart Buildings
Atlanta, GA,
United States

bertrand.vandewiele@us.abb.com

Smart buildings
Smart buildings have functions that can monitor energy use, offer predictive maintenance, measure indoor air quality (IAQ), manage thermostats, map occupant location and track building use – thus giving their owners and operators an implicit understanding of the behavior and requirements of occupants and their interactions with the space. Once this knowledge is at hand, operations can be tailored to provide the best comfort and convenience for the occupants, which drives their well-being and productivity. At the same time, energy usage and operational costs can be optimized →01.

ABB Ability Building Ecosystem
The path that leads to all the benefits of a smart

02

—
01 ABB Ability Building Ecosystem is a holistic suite of solutions that provide the simplest path to a smart building.

—
02 Smart buildings deliver a wide range of benefits, such as emissions reduction and energy savings.

building may seem difficult, but ABB Ability Building Ecosystem makes the journey uncomplicated. This open and scalable digital platform fits most building needs, enabling users to optimize their space and improve energy efficiency. ABB Ability Building Ecosystem revolutionizes how data is used, and transforms building management – not just through greater energy efficiency and increased security, but also by providing an environment that is more secure, comfortable and productive →02.

ABB has long experience in core building systems and the seamless automation of a building's electrical and mechanical infrastructure. ABB exploits its ABB Ability technology and advances smart building systems with ABB Ability Building Ecosystem so that these digital-driven tools are accessible to owners of buildings of any scale, large or small – smart building technology is no longer the domain of mega towers and corporate giant headquarters. Easy to use and understand, these intelligent digital tools provide meaningful data that users (or artificial intelligence algorithms) can analyze and respond to in real-time.

ABB Ability Building Ecosystem itself is a holistic suite of solutions that the user can access easily via one unified online portal. The suite's components are straightforward to integrate as they are fully compatible with existing systems installed in today's buildings that leverage ABB's open architecture. They run on simple hardware – the ABB Ability Building Edge – and are powered by ABB's open Building Operating System (openBOS®). Scalable and adaptable to future needs, the modular nature of ABB Ability Building

ABB Ability Building Ecosystem is a holistic suite of solutions that the user can access easily via one unified online portal.

Ecosystem gives the flexibility to choose and pay for only the components that are required. As the situation in a building evolves, functionality from ABB or a third party can be added with no fuss.

The ABB Ability Building Ecosystem suite comprises two main modules: ABB BE Sustainable with Active Energy and ABB BE Space Efficient.

BE Sustainable with Active Energy
Managing energy costs in a building can often be a challenge, especially when the building is large and the spaces within it are used for a diverse range of activities →03. ABB Ability BE Sustainable with Active Energy (BE stands for building ecosystem) greatly simplifies this energy management task. Active Energy is a tool that allows the user to measure and identify utility usage (electricity, water, gas, etc.) in real-time instead of waiting for a utility bill to arrive. Active Energy displays a live view of this usage for immediate evaluation. This real-time data can be analyzed and well-informed decisions made to improve a building's energy consumption and reduce costs and emissions in a proactive manner. Expected versus actual usage is tracked and alerts can be set up to inform the user if any set limits are exceeded.

The suite can be applied to one space or room, an entire building, or a portfolio of buildings.

Active Energy also helps the user meet corporate sustainability goals as all metrics needed to prove efficient operation and obtain certification levels that comply with legislation and industry standards are already integrated into the software. Custom reports are easily generated to help compliance validation – which is very relevant for organizations setting up their net-zero key performance indicators (KPIs) and sustainability pledges. The software can also be tailored to meet specific business operational profiles and keep track of other KPIs. Because Active Energy is a cloud-based software-as-a-service (SaaS), there is no limit to the number of meters or sensor points that it can serve. A cyber-secure connection to the service is possible from any geographical location.

BE Space Efficient for Meeting Rooms
ABB Ability BE Space Efficient with Meeting Rooms enables the user to respond rapidly to the changing needs of building occupants by monitoring offices, conference rooms and other spaces – thus assuring better air quality and building safety as well as improved tenant comfort, health and productivity →04. The data collected gives a real-time insight into meeting spaces, with capacity metrics that include heat maps, floor plans and occupancy patterns so that comfort levels can be adjusted accordingly while optimizing energy usage.

With Meeting Rooms, remote adjustments to room temperature, lighting and airflow can be made to correct anomalies. Further, sensors in the room ensure that the heating, ventilation and air conditioning (HVAC) system is turned off when a window is opened. Temperature is adjusted and lights are switched off automatically when rooms are unoccupied. For the first meeting of the day, spaces can be preheated or precooled to ensure an optimal temperature, or purged to maximize fresh air depending on air quality conditions. In general, because Meeting Rooms can be seamlessly integrated with the Office 365 calendar interface, it is able to look ahead and predict how spaces should be managed.

Awareness of occupancy levels allows a prioritized cleaning regime in which alerts are generated to clean and sanitize spaces with heavy traffic while unnecessary cleaning of unused areas is avoided.

Comfort and decarbonization
The ABB Ability Building Ecosystem holistic suite of solutions provides the simplest way to optimize indoor space utilization. The suite can be applied to one space or room, an entire building, or a portfolio of buildings and helps meet sustainability goals and keep track of KPIs to prove real progress →05. Easily integrated with existing infrastructure and fully compatible with open system architectures, the tool can be adapted to meet different requirements as smart building needs change within a building. A full suite of ABB Ability Building Ecosystem solutions for building optimization will evolve as additional components are added.

ABB Ability Building Ecosystem is designed to deliver significant benefits for building owners and occupants. Such solutions for decarbonizing buildings and sites will take ABB closer to its target of carbon neutrality by 2030 and help customers reduce their annual CO_2 emissions by an estimated 100 million tons – a key target of ABB's 2030 sustainability agenda. •

—
03 Optimizing a building's performance can be challenging when its spaces are put to a wide variety of uses.

—
04 ABB Ability BE Space Efficient with Meeting Rooms responds rapidly to changing room utilization.

—
05 The ABB Ability Building Ecosystem suite can be applied to one space, an entire building, or a building portfolio.

—
References

[1] "ABB wins 2021 Frost & Sullivan global product leadership award for intelligent buildings," ABB Press release, December 2021. Available: https://new.abb.com/news/detail/85701/abb-wins-2021-frost-sullivan-global-product-leadership-award-for-intelligent-buildings [Accessed December 17, 2021].

[2] Architecture 2030, "Why The Building Sector?" Available: https://architecture2030.org/why-the-building-sector/ [Accessed November 11, 2021].

[3] I. Campbell and K. Calhoun, "Old Buildings Are U.S. Cities' Biggest Sustainability Challenge," Harvard Business Review, 2016. Available: https://hbr.org/2016/01/old-buildings-are-u-s-cities-biggest-sustainability-challenge [Accessed November 11, 2021].

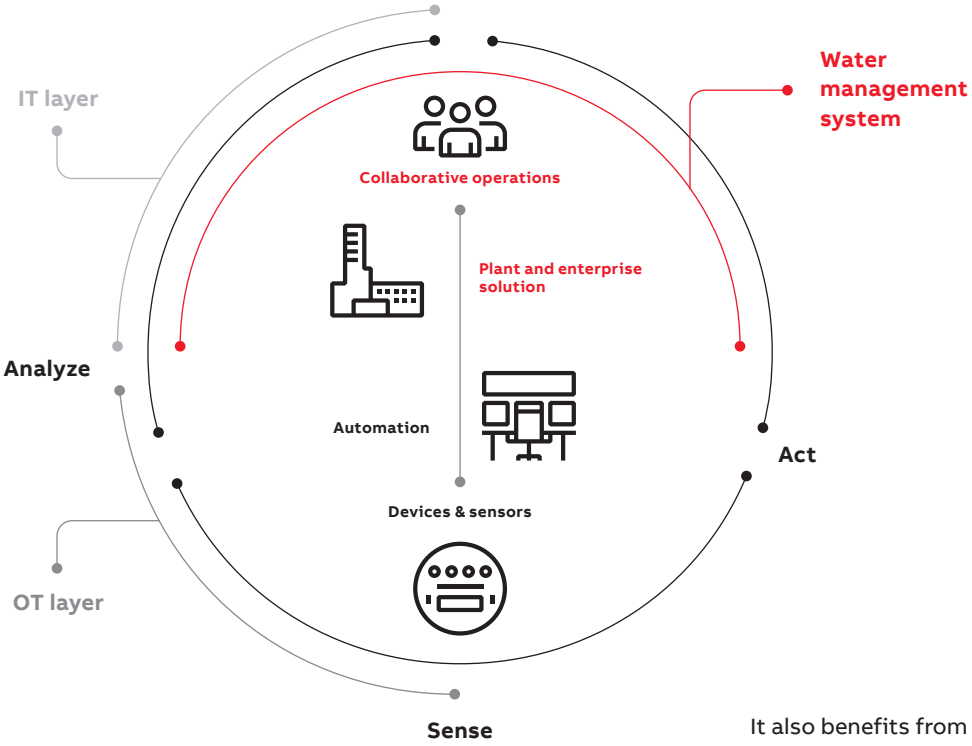
Title photo: Michelle Kiener

AN EXPERT SYSTEM TAPS NEW PATHS TO BETTER DECISIONS

Optimizing water management

ABB has introduced a water management platform that opens the door to new functions by bridging the gap between operational and information technologies. Basically an expert system equipped with reasoning capabilities, the platform's ability to connect dots holds potentially enormous value in areas such as strategic planning, asset management and reporting, as it helps operators to spot anomalous conditions, identify the root causes of problems, compare patterns, and even simulate scenarios.

Water resources and related infrastructures are experiencing an unprecedented array of challenges. These include increasing levels of water scarcity, growing coastal salinity, pollution, infrastructure degradation, tightening regulations, and the limited willingness of many governments and communities to recognize the crucial economic impact of these threats. As a result, operators of water systems are responding with a renewed focus on efficiency, which is being driven by adopting an increasingly



01

Marco Achilea
Power & Water,
ABB Energy Industries
Genoa, Italy

Marco.achilea@
it.abb.com

Gianluca Rolandelli
Power & Water,
ABB Energy Industries
Genoa, Italy

gianluca.rolandelli@
it.abb.com

—
01 ABB's Water Management System (WMS) bridges the gap between operational technologies and information technology.

data-driven approach to operations – a strategy designed to increase the transparency of systems throughout their networks, thus supporting a process of steadily improving decision making and improved handling of unplanned events.

In view of these developments, ABB has introduced its Water Management System (WMS) software solution, a highly extensible and configurable platform. The platform allows operators to completely integrate existing third-party components, be they systems or devices, regardless of their interfaces or application verticalizations. This bridges the gap between operational technologies and information technology layers and opens the door to new functions →01. This ability to connect dots holds potentially enormous value in areas such as strategic planning, asset management, and reporting, as it helps operators to spot anomalous conditions, identify the root causes of problems, compare patterns, and even simulate scenarios.

Deep domain knowledge
Designed to be an expert system for water utilities, ABB's WMS employs knowledge about its application domain and uses an inferencing (reasoning) procedure to solve problems that would otherwise require mixed human competence or expertise combined with huge computational capability.

WMS's power stems primarily from its deep domain knowledge, which is based on project experience and collaborations with customers.

It also benefits from ABB's partnership with DHI, a leading global advisory company specialized in water management and related ecosystems [1]. Thanks to this collaboration, WMS is capable of modelling complex systems and providing insights into hydraulics.

The platform's design →02 is based on several fully decoupled and modular layers that allow it to integrate data sources, regardless of whether they are external systems or IoT devices. Furthermore, thanks to an homogenization layer made up of custom connectors, it is possible to integrate and contextualize disparate data elements and store them in a cognitive model or cognitive data lake that is industry specific and understands the industry context.

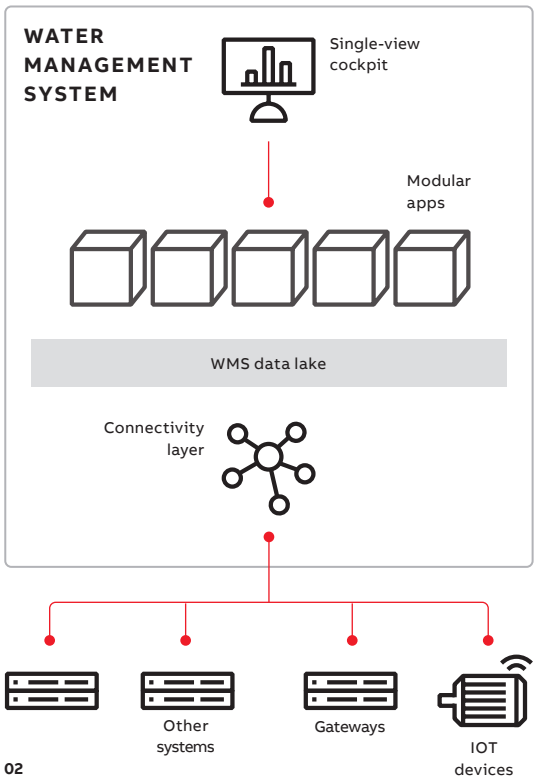
—
WMS offers deep domain knowledge, which is based on project experience and collaboratons with customers.

As these processes take place, data converges toward middleware that offers transversal services, while being particularly cognizant of security considerations such as access control and data exchange, as well as performance considerations, such as caching mechanisms, data ingestion and storage, and message brokering. The end result is a "single-view cockpit" web application →03 that is complemented by a fully-responsive HMI (human machine interface) that balances design and usability.

—
02 The WMS platform's design is based on several fully decoupled and modular layers that allow it to integrate a variety of data sources.

—
03 The WMS platform provides a "single-view cockpit" web application that is complemented by a human machine interface that balances design and usability.

—
04 WMS modules.



02

of each district or district metered area (a discrete part of a water distribution network)
- Report automation that can run and export pre-built reporting templates (eg, for regulation authorities) or ad-hoc reports
- Advanced simulation with a geospatial digital twin feature relying on a dynamic hydraulic model running on the back-end
- Water quality based on an ad hoc module that can monitor water age, contaminant events, and relevant water quality KPIs

Moreover, WMS fits into the broader ABB Ability™ offering, thus empowering real-time, data-driven decisions that maximize resource efficiency and contribute to a more sustainable world. The platform can collect data from any kind of source thanks to its IoT / connectivity layer, which can leverage the full capabilities of the ABB Ability Genix platform in terms of data collected from field / remote sites (including telemetry and data from low bandwidth connections eg via radio bridges).

The platform can also collect data from pre-existing SCADAs (or other third party systems) and / or directly from the field (including smart meters or IoT devices) through OPC UA/DA, MQTT, AMQP protocols. Finally, all data are harmonized and stored in the data lake for the apps and the WMS. •

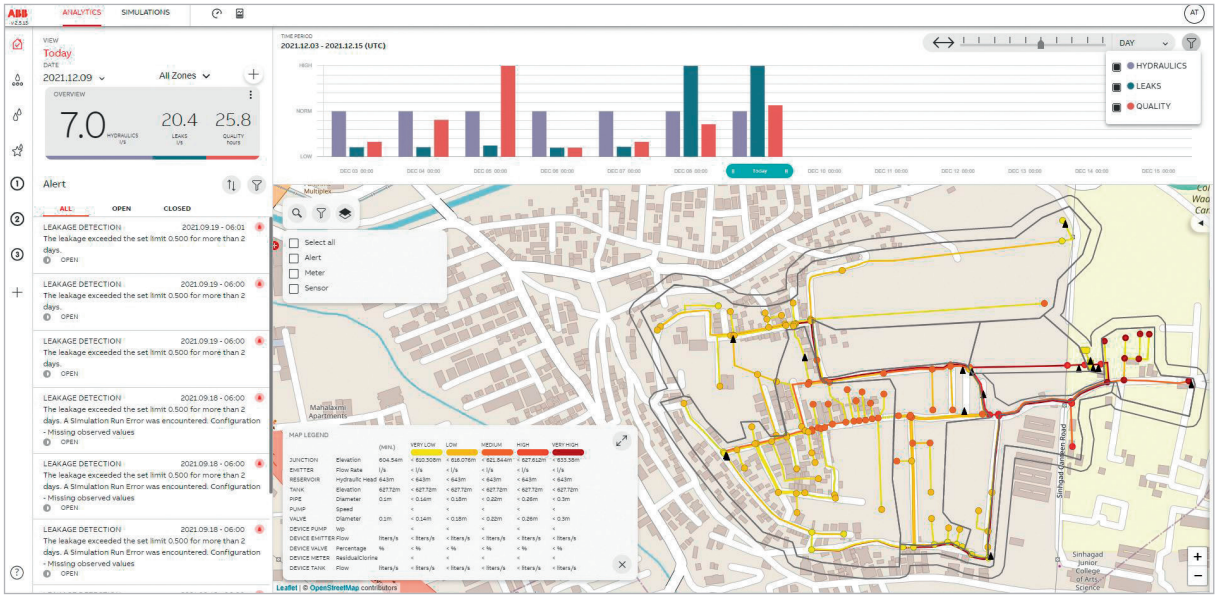
Practical applications

ABB's Water Management System offers a range of applications. Thanks to its high level of modularity →04 and scalability, it can help water companies tackle the following challenges:

- Real-time operations monitoring based on a data collection layer and a data lake tailored to a water distribution network data model
- Leakage detection based on a water balance module capable of calculating the performance

—
References

[1] ABB. ABB and DHI Join Forces. Available at: https://new.abb.com/news/detail/84125/abb-and-dhi-group-join-forces-to-create-smarter-more-sustainable-water-management-solutions [Accessed November 19, 2021].



03

WMS MODULES: HELPING CUSTOMERS OVERCOME CHALLENGES

District performance
District performance allows real time analysis of water management performance based on inflows and consumption data as retrieved by the supervisory control and data acquisition (SCADA) system. For each area, WMS reports different KPIs, such as water leakages and related costs, including all standardized IWA parameters. Additional local parameters and indicators are available on demand. Based on real time data, the tool automatically detects new bursts and anomalies and generates alarms according to predefined rules and thresholds. In addition, the module facilitates the dissemination of data to authorities with a view to supporting daily operations and long-range planning of financial and technical resources in reducing leakages.

Network twin
Network twin enables a real-time replica of a water network based on hydraulic modelling and data from SCADA. WMS automatically retrieves information from all sensors in a network in order to simulate the state of all controllable structures, such as valves, pumps, etc., together with the water levels in tanks, water demand, etc. A hydraulic model that replicates the network is automatically prepared by the system, allowing the representation of discharges, pressures, and water quality in each pipe. This makes it possible to better understand the behavior of the network and support operations and optimizations based on automatic warnings when anomalies are detected. The platform also makes it possible to dynamically compare real observations and simulated data in order to check model accuracy.

Scenario manager
Network Scenario Manager includes a wide range of advanced analyses based on the availability of the hydraulic model. As previously mentioned, “Network Twin” offers real-time simulation of a network’s condition. Scenario Manager, on the other hand, allows the user to run advanced analyses both in terms of hindcast and forecast simulations. The hindcast module allows the simulation of past conditions, taking into account the state of all controllable structures as observed physical variables (water levels, water demands, etc.).

The forecast module makes it possible to simulate future conditions several days in advance based on predefined water demand profiles. What-if scenario simulations make it possible to compare alternative operations in the network (opening or closure of valves, changes in set points, etc.) as well as in terms of water demand. The WMS graphical interface helps the user to compare model results and identify best practices as optimization strategies.

Water Quality
This module includes real-time online analysis of water quality in the network in terms of water age and specific solutes, including routing from different sources. Quality data is collected and visualized for immediate monitoring of KPIs. Moreover, virtual sensors and digital twins can be used in order to run advanced simulations regarding water age estitimation, source tracing evaluation, and contaminat event what-if analysis.

Asset Performance
This feature provides advanced analytics and integrated views of assets (pumps, motors, pipes, pressure relief valves, storage tanks, etc). This includes analytics on asset performance, health deviations, preventive maintenance, failures, corrective maintenance, asset event history and cost of maintenance, including generation of specific alerts in case of deviations. As this module evolves, equipment failure predictions based on data-driven algorithms will be possible. These will analyze the behavior of a group of historical parameters to estimate time to failure (eg, predict performance degradation of a pump).

Network optimization
This module, which is based on embedded AI/ML techniques, is designed to improve performance (hence reduce overall cost) on a real-time basis. Optimum outputs in the form of set-points, advisories, etc., are communicated to registered users to support insights, planning and actions. The module has the capability to model the development of processes, balances, and assets, as well as the ability to optimize the same based on analytical insights. It can also build soft sensors, thus minimizing physical deployment. Optimizations can be performed for energy efficiency (eg, network energy balance), asset performance (eg, variable best efficiency point), and processes (eg, flow balance).

BETTER DECISIONS IN CEMENT STRENGTH PREDICTION WITH ARTIFICIAL INTELLIGENCE

Cementing the edge

It has been said that “software ate the world, now AI is eating software” [1]. The growth of artificial intelligence (AI) is relentless [2] – the process-automation sector being no exception. More and more analytics applications are processing data from online sensors and laboratories, making processes more efficient and increasing process autonomy. The last decade has seen a trend towards such applications being deployed in the cloud. However, in many cases, it is not practical to transfer huge masses of data to the cloud. Hence the emergence of edge analytics.

In edge analytics, processing tasks are executed in the proximity of where the data is generated (eg., on site) in order to enable faster response times [3] [4]. Example applications in process automation include asset-condition monitoring, process-function monitoring, and anomaly detection, with areas of deployment extending to smart cities and smart transportation [5]; edge computing is rapidly becoming a leading digital technology.

Edge computing and edge analytics provide many benefits:

- The physical proximity to the devices makes it easier to achieve low latency and high bandwidth. This means higher volumes of data can be processed with faster response times.
- Processing data on the edge reduces data traffic to the cloud, as only filtered and/or aggregated information needs to be transmitted.
- On the edge, it is easier to protect applications and data with respect to cyber security, as data is processed locally, before releasing parts of it to the cloud via a secure edge gateway, ie, the attack surface is smaller.
- Edge nodes can operate even when cloud services are unavailable due to network or cloud failures, or for mobile equipment like trucks, which may have intermittent internet connection. Data privacy considerations may also favor this solution. Edge processing therefore improves availability and reliability for key services.
- Legacy devices that cannot establish their own cloud connections can be integrated into edge-based system architectures.
- Edge resources are usually less expensive than cloud resources.

Edge computing complements cloud computing as data- and resource-intensive tasks (such as training of machine learning models) can be moved to the cloud, while the actual prediction can be deployed on the edge. All in all, the emergence of edge analytics introduces many possibilities for industrial analytics.

The ABB Ability™ Genix Industrial Analytics and AI Suite enables vast potential for edge analytics. This article presents a research-level proof of concept, illustrated by the use case of cement strength prediction.

Example: Cement strength prediction

In the cement-making process, the quality of cement is influenced by many factors →01. Variability in raw feed and fuel types means that cement production is rarely constant. Continuous changes in plant operating points are needed to counter this variability, guided by online and lab measurements. A particularly important quality is “28-day cement strength.” If cement strength is too low, it cannot be sold, or requires blending with a higher-grade of cement. Conversely, cement strength that is too high comes at the cost of either reduced yield or excessive additives (which means excessive costs). Traditionally, there is a delay of 28 days until it is possible to test cement strength. By then it is too late to make corrections in the process. This means plants often over-deliver on the cement strength specification at reduced profit potential.

Traditionally, there is a delay of 28 days until cement strength can be tested – too late to make corrections in the process.

Having a way to predict the 28-day cement strength during production, preferably many times a day, could enable plants to respond in a much more timely manner. ABB tackled this challenge using machine learning functions within the ABB Ability™ Genix Industrial Analytics and AI Suite. Models were built in ABB Ability™ Genix using its Model Fabric component to map sampled data and predict 28-day cement strength →02. Multiple proposed models were reviewed in Genix Model Fabric for accuracy and robustness before a final model was selected →03. This model was then deployed on the edge to predict 28-day strength based on production data provided every 2-3 hours.

The ongoing accuracy of the on-premise model will be monitored before action is potentially transferred to another ABB technology: the ABB Ability™ Expert Optimizer. This technology automatically makes corrective changes to

Marie Platenius-Mohr
Jan Schlake
Michael Vach
ABB Corporate Research
Ladenburg, Germany

marie.platenius-mohr@de.abb.com
jan-christoph.schlake@de.abb.com
michael.vach@de.abb.com

Ryan Koorts
ABB Process Automation
Dättwil, Switzerland

ryan.koorts@ch.abb.com

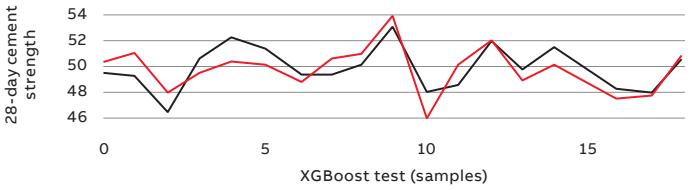
Anders Trosten
ABB Process Automation
Vaesteras, Sweden

anders.o.trosten@se.abb.com

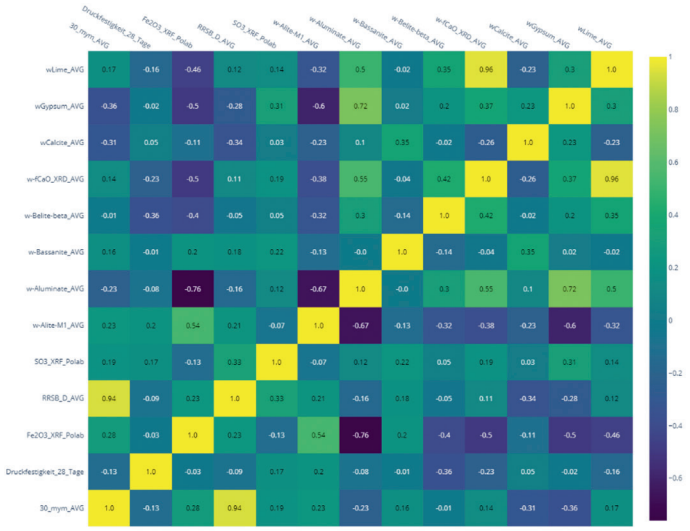
Vinod Ninan
ABB Process Automation
Bangalore, India

vinod.ninan@in.abb.com

01



02



03

the production process and will aim to reduce variability and achieve a more constant 28-day cement strength closer to target. Expected benefits of achieving this target are increased yield with reduced additive consumption costs.

ABB Ability™ Genix Industrial Analytics and AI Suite

The ABB Ability™ Genix Industrial Analytics and AI Suite [6-7], is a scalable, advanced analytics platform with pre-built, easy-to-use applications and services. ABB Ability™ Genix is designed to improve customer decision-making by predicting

—

The use of different security zones ensures that the security of the process automation system is not compromised.

and optimizing asset, plant, and enterprise performance. Genix assists customers in designing and applying analytics. It unlocks the value of data by combining ABB's deep industrial domain expertise with digital technology and capabilities.

ABB Ability™ Edgenius Operations Data Manager

Edgenius [8] is ABB's edge component for industrial software applications and can be applied

—
01 Cement manufacturing presents scope for process optimization using edge computing (the photograph shows an instalation of the Qassim Cement Company for which ABB provided process-control solutions).

—
02 Cement strength prediction vs actual for training and test data (training data above, testing below with red being actual data and black predicted).

—
03 ABB Ability Genix™ Correlation matrix.

as a standalone operational data collection and computation manager, or embedded in the Genix Suite in order to incorporate operational data into analytics in a robust manner. It includes multiple modules to gather data from operational technology, such as distributed control systems and instruments, or via OPC protocols. With Edgenius' streaming calculation engine, real-time data can be made available with minimal latency. Easy deployment, configuration and monitoring of edge nodes and applications across the entire enterprise is enabled via the Edgenius Management Portal.

Edgenius fully addresses NAMUR Open Architecture (NOA) requirements [9]. Following the intent of NOA, Edgenius leaves the Core Process Control (CPC) of a process plant unchanged and secure, while providing additional IoT functionality in the so-called Monitoring and Optimization domain (M+O). The use of different security zones ensures that the security of the process automation system is not compromised even though data and information is flowing from the process to the M+O modules. Furthermore, separation of the lifecycles of CPC and M+O modules is achieved, leading to faster updates and greater speed of innovation.

Integrated Edge Analytics Workflow
The integrated workflow for an edge analytics solution implementing the above cement-strength prediction is shown in →04. The view distinguishes between the training phase, where the AI/ML model is created and trained; and the operations phase, where the model is used to predict results during production.

The Model Fabric component allows any non-expert data scientist to explore and pre-process the data in order to create a machine learning pipeline. The cement strength prediction model has been automatically trained and optimized using an AutoML approach in the following modules of Model Fabric:

- Data exploration: The prebuilt data exploration capability of Model Fabric helps the quick and easy "data understanding" for a business or a data scientist.
- Data preprocessing: Data is preprocessed based on proven data-science methods and techniques before it goes to the model building stage.
- Model building: The preprocessed data is split into training and testing data sets and models are built with multiple proven learning algorithms. Model fabric takes care of appropriate "validation" as well as fine tuning of parameters while building the models. Once models are built it provides evaluation metrics along with plots and suggestions concerning the choice of models.
- Model registry and deployment: Model fabric supports the complete life cycle of AI/ML model. Once the model is built, this module provides hassle free model registry and deployment.

The resulting model is used in the operations phase. It is deployed from Genix Model Fabric as part of a ONNX model prediction app, which uses the ONNX [10] inference engine (ONNX=Open Neural Network Exchange, an open standard for Machine Learning model exchange). ONNX provides interfaces to many available frameworks (eg, TensorFlow and ScikitLearn) without regard to detailed model implementation. The ONNX model prediction app is deployed in Edgenius as a Docker [11] container with a RESTful Application Programming Interface. This means that it can be implemented in any programming language that provides the functionality to create an HTTP endpoint.

—
With Edgenius' streaming calculation engine, real-time data can be made available with minimal latency.

For retrieving production data, a connect module, KM Connect, connects to the ABB Ability Knowledge Manager (KM) system and feeds the cement input values coming from KM into the edge system. For further use cases, other connect modules can be used, such as Distributed Control System Connect to connect to an ABB Ability 800xA DCS, or OPC UA Connect to interface to an OPC UA server. To bring the data and the AI/ML model together, the Edgenius Streaming Calculation Engine maps data streams to the inputs of the prediction function and triggers the function periodically or at defined events.

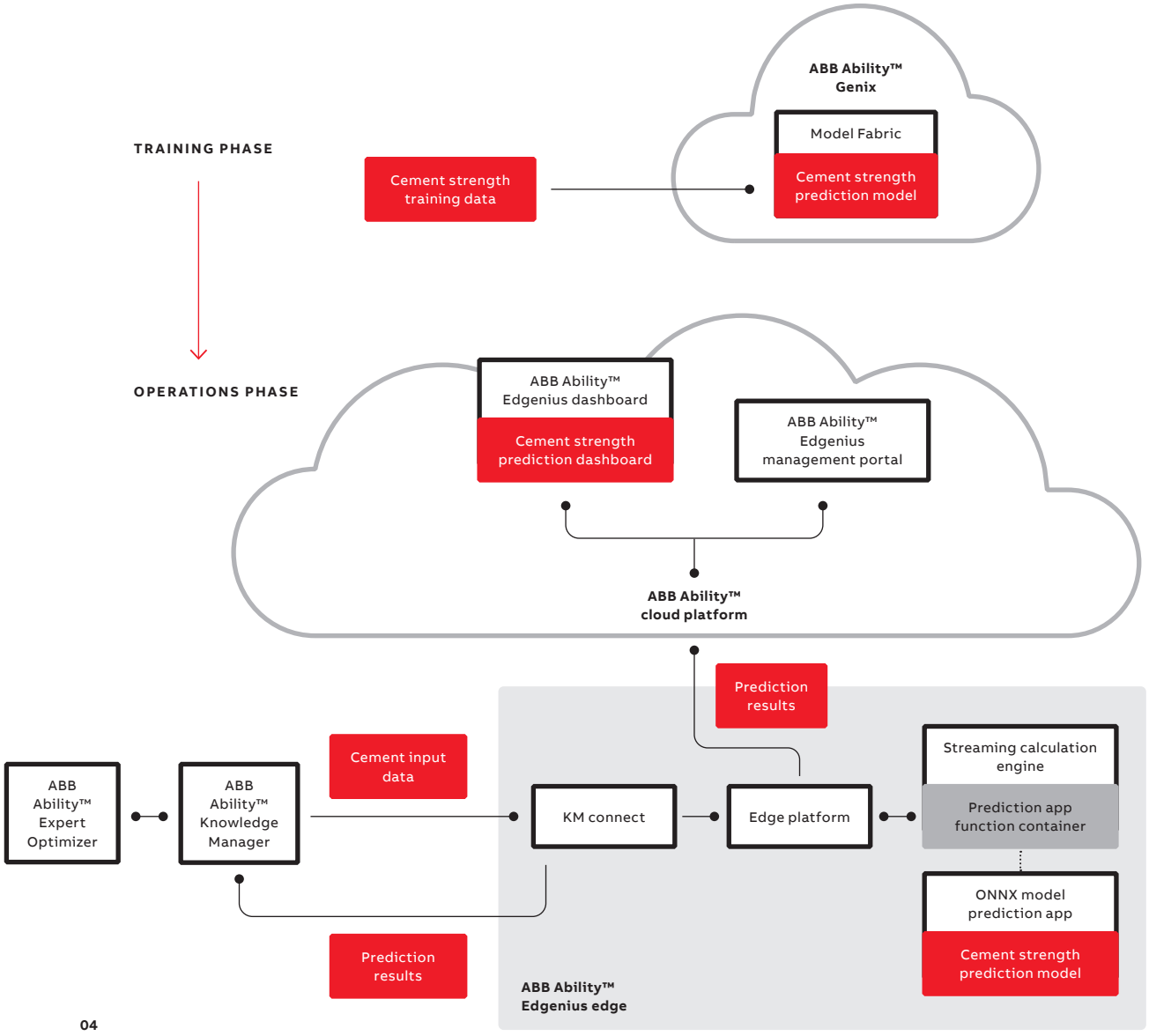
This workflow is a loop that can be adjusted over time.

Screenshots of the described workflow are shown in →05, which starts at (a) with Genix Model Fabric. (b) is a view of an edge in the Edgenius Management Portal. The left part of this screen shows general information, while the installed applications are displayed on the right. (c) shows how the inputs of the KM Connect module are mapped to the deployed cement strength prediction function within Edgenius' Streaming Calculation Engineering Tool. The predicted results, ie, the expected cement strength values, are transferred back to the KM and potentially to Expert Optimizer in order to apply corrective changes. The results can also be visualized using Edgenius dashboards (d).

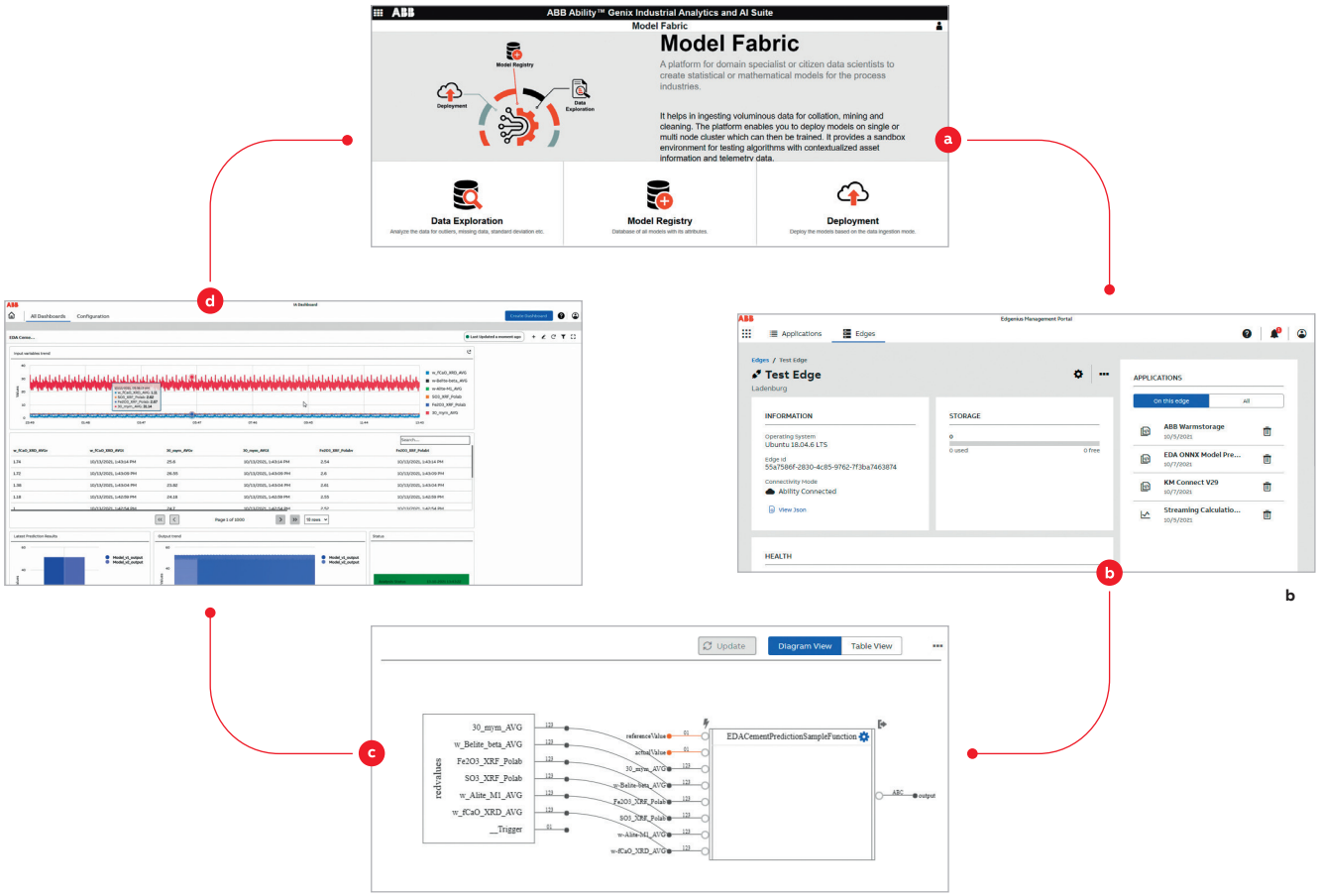
This workflow is a loop that can be adjusted over time: ie, whenever the deployed AI/ML model is detected to not be optimal anymore (eg, because environmental conditions changed), in such situations the model can be retrained and redeployed.

An applicable solution

The proof of concept presented in this article of using the division between cloud and edge, is applicable to all types of inferential decision making across all industries. It is presently still at a research level, but ABB hopes to offer it to



04



b

—
04 Integrated Edge Analytics Workflow for Cement Strength Prediction.

—
05 Workflow in screens.

customers soon. The goal will be to make it easy to build, deploy and maintain models.

In the future, it is to be expected that edge analytics applications will become even more advanced and complex. Instead of focusing on one edge or on a few edges, the development can be expected to evolve toward hierarchical edge networks and edge meshes. This opens the door to powerful distributed analytics techniques. •

—
The division between cloud and edge, is applicable to all types of inferential decision making across all industries.

—
References

[1] M. van Attekum, J. Mei und T. Singth, “Software Ate The World, Now AI Is Eating Software,” Forbes, 2019. [Online]. Available: https://www.forbes.com/sites/cognitiveworld/2019/08/29/software-ate-the-world-now-ai-is-eating-software/ [Accessed March 31st, 2022].

[2] Gartner, Inc., “Gartner predicts the future of AI technologies,” 2020. [Online]. Available: https://www.gartner.com/smarterwithgartner/gartner-predicts-the-future-of-ai-technologies/[Accessed March 31st, 2022].

[3] M. Satyanarayanan, “The emergence of edge computing,” *IEEE Computer*, Bd. 50, Nr. 1, pp. 30–39, 2017.

[4] J. Perino, M. Littlefield und V. Murugesan, “Edge Computing in the New OT Ecosystem”, “https://resource.stratus.com/whitepaper/edge-computing-in-the-new-ot-ecosystem/,” LNS Research, Stratus, 2020. [Accessed March 31st, 2022].

[5] M. Platenius-Mohr, H. Abukwaik, J. Schlake und M. Vach, “Software Architectures for Edge Analytics: A Survey,” in *European Conference on Software Architecture* (ECSA’21), Springer, 2021.

[6] (ABB web page on Genix), https://new.abb.com/process-automation/genix [Accessed March 31st, 2022].

[7] ABB Ability Industrial Analytics and AI Suite, de Leeuw, V, ARC White Paper, July 2020, https://search.abb.com/library/Download.aspx?DocumentID=9AKK107680A9852&LanguageCode=en&DocumentPartId=&Action=Launch [Accessed March 31st, 2022].

[8] ABB Ability™ Edgenius Operations Data Manager, ABB web page, https://new.abb.com/process-automation/edgenius [Accessed March 31st, 2022].

[9] (NAMUR), User Association of Automation Technology in Process Industries, “NE 175: NAMUR Open Architecture – NOA Concept,” 2020.

[10] Open Neural Network Exchange (ONNX) website, https://onnx.ai/ [Accessed march 31st, 2022]

[11] Docker corporate website, https://www.docker.com [Accessed March 31st, 2022]

BETTER DECISIONS WHEN SWITCHING TO DIGITAL SWITCHGEAR

Switch to digital

The electrical distribution backbone is comprised of medium- and low-voltage switchgear. By using digital switchgear and analyzing the data coming from it, operational costs can be minimized. Cost-saving methods include monitoring of circuit breakers, feeders and motor starters.

01

—
01 Digital switchgear achieves significant cost savings when compared to traditional approaches.

In an increasingly electrified world, switchgear plays a critical role in delivering constant, reliable electric power to almost every application imaginable. The task of switchgear is to transfer electricity safely and effectively from the medium-voltage (MV) – up to 40.5 kV – supply

—

Digital switchgear liberates data from device silos to make it available for analysis, leading to cost-saving actions.

coming from power plants and utility networks to low-voltage (LV) – up to 690 V – distribution networks. Switchgear encompasses a number of electrical devices, such as circuit breakers, power monitors, motor and feeder controls, and protection devices.

The hidden cost of traditional switchgear technology

There are many hidden costs of traditional switchgear that can add up over the lifetime of the switchgear to significant totals, for example:

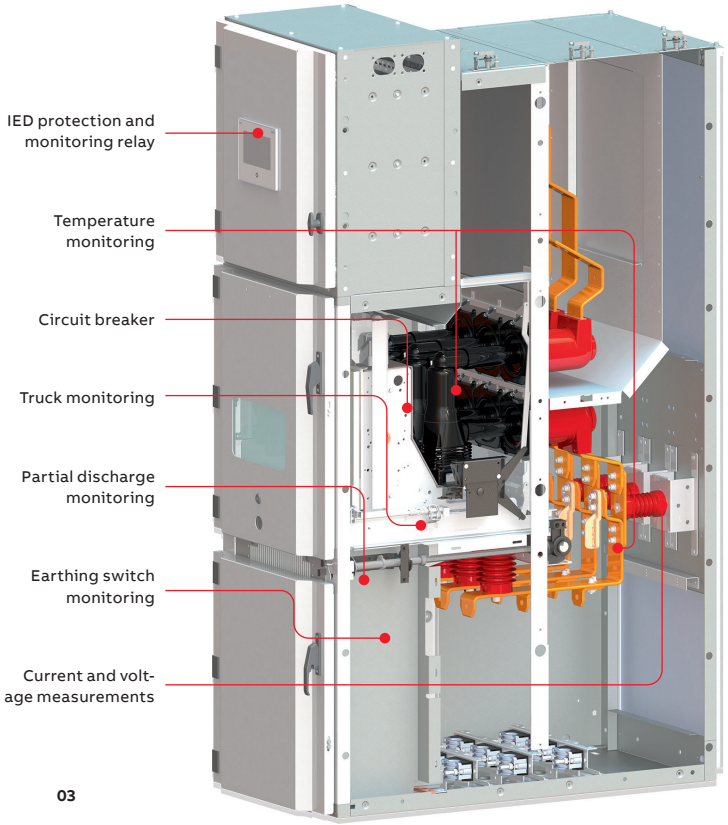
- The initial cost of device implementation and correct parameter value-setting, which can be time-consuming if the necessary information is hard to find.
- Coordination friction between the engineering and commissioning team when the design does not fully match on-site reality.
- Switchgear testing, including manual operational data collection and report creation, which can require costly and time-consuming coordination between the buyer, operator and manufacturer.

Operational costs are also a significant overhead in traditional switchgear. These expenditures include regular visual inspection, function checks and maintenance that is conducted on a preventative rather than an as-needed basis. Even worse, lack of insight into a device's condition means operators are often forced to perform reactive maintenance, retain a collection of expensive spare parts or keep a trained maintenance team available in case of device failure.

Gunnar T. Zank
ABB Electrification, Distribution Solutions
Heidelberg, Germany

gunnar.t.zank@de.abb.com

02



03

Despite being more expensive and disruptive, reactive maintenance is still far more common than preventative maintenance.

Further, switchgear has an average lifetime of 30 years. As power demands change over that time, it can be difficult for operators to calculate whether there is sufficient electrical and thermal capacity in the existing switchgear to support new components. This can lead to new equipment being purchased unnecessarily.

Unlocking data unlocks cost savings

Electrical infrastructure already produces data. For example, protection relays count operation and trip cycles and this data can then be used to estimate contact wear and other breaker conditions. Motor controllers – employed in everything from industrial operations to air conditioning – can collect data on motor load conditions that helps the operator detect problems in motors or attached machines. However, the data these smart devices create is only as useful as the user's ability to collect, access and take action on it.

In many cases, data remains where it is due to the lack of the specialized knowledge needed to set up and program the smart devices, fieldbuses and Ethernet communications required to access it. However, if accessed and incorporated into a single system, this data could be used to identify the right threshold settings, monitor ongoing performance and help drive cost-effective predictive switchgear maintenance based on actual condition information, which is far preferable to waiting for a costly failure to occur.

Digital switchgear massively simplifies the task of liberating data from device silos to make it available for analysis, enabling cost-saving actions to be identified →01.

The advantages of digital switchgear
With a digital switchgear solution, the operator can not only collect data automatically, but also store and analyze it to facilitate data-driven decisions while applying lifetime analytics for further value creation. This data can be used, for example, to provide condition monitoring that can:

- Verify switchgear function and performance before a factory acceptance test
- Demonstrate the switchgear's condition with a condition report during factory acceptance tests and commissioning
- Identify elements that need repair before they fail during operation
- Analyze performance data to determine condition-based maintenance requirements
- Better plan maintenance in advance and shift from preventive to predictive maintenance

Moreover, with on-site data collection throughout the switchgear's lifetime, digital switchgear solutions provide the basis for asset management solutions that better estimate the remaining useful life of electrical equipment and the probability of failures.

An even more effective approach is to add comprehensive condition monitoring to the switchgear or the site's entire electrical assembly – eg, with ABB Ability™ solutions. These solutions uses sophisticated data analysis and algorithms to automatically and continuously convert data from the devices into actionable insights that are easily accessible to maintenance personnel via a dashboard. Together with past lifetime data such as commissioning date, maintenance dates and performed maintenance, this data will become actionable information that drives decisions.

—
02 The monitoring of MV switchgear, such as that shown here, is accomplished via Ethernet-based communication links.

—
03 Internal view of an MV switchgear (Unigear Digital).

Switchgear digitalization is not only for new installations – any switchgear can be digitalized by adding smart devices and sensors as desired.

Smart communications, devices and sensors for digital switchgear
Digitalization of switchgear involves an array of technology. For example, for monitoring purposes, digital MV and LV switchgear is connected via Ethernet-based digital communication links, including the widely used IEC 61850 and Modbus TCP or OPC UA →02. These communication protocols are commonly found in Industrial Internet of Things (IIoT) platforms.

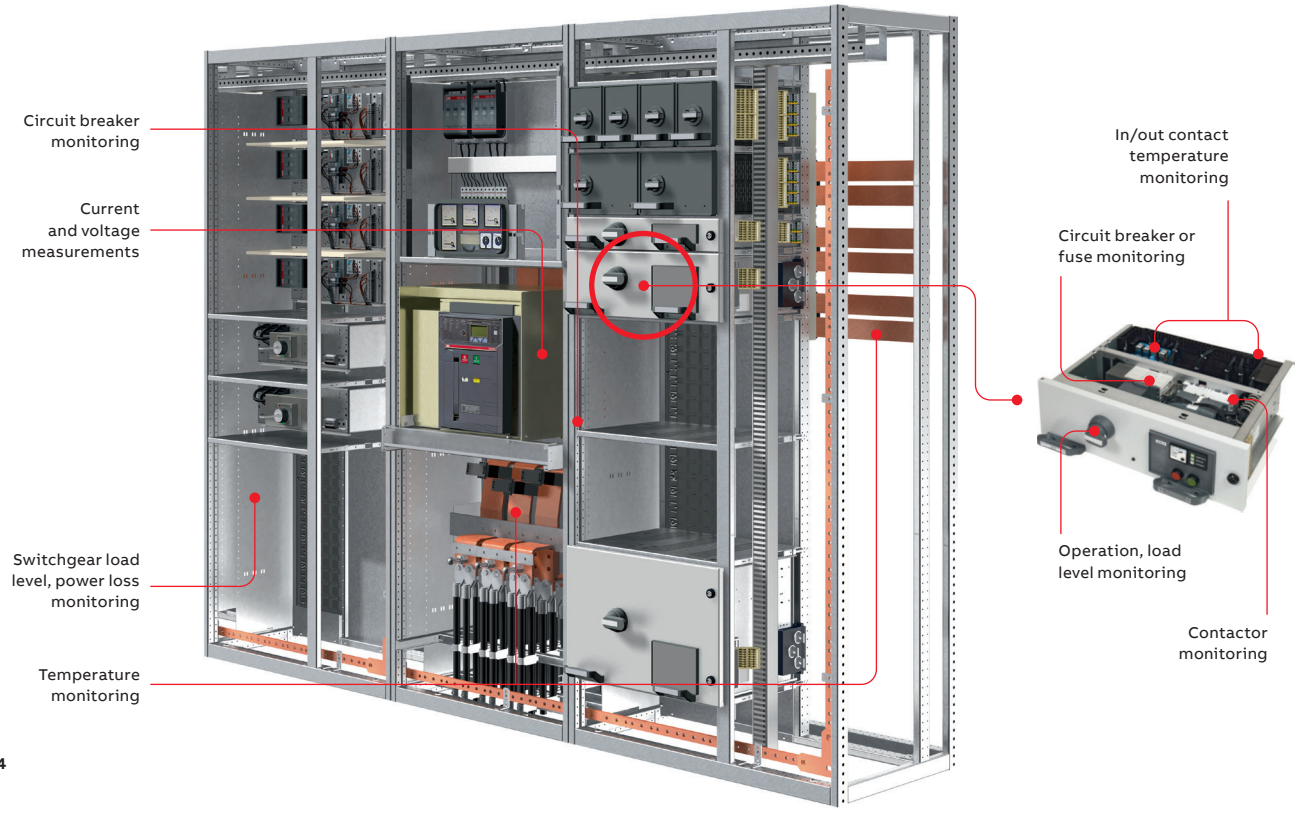
Circuit breakers, together with intelligent electronic devices (IEDs), such as ABB's Relion® relays or Ekip control and protection units for LV breakers are core elements of switchgear digitalization. IEDs not only perform control and

—
Any switchgear can be digitalized by adding smart devices and sensors as desired.

protection functions but include a feature for circuit breaker condition monitoring that provides an operator with data that can be analyzed and used for scheduling circuit breaker maintenance or functional testing. At the same time, a runtime counter enables the scheduling of time-based maintenance for the connected motor or transformer. Data collected includes:

- Electrical parameters such as current, voltage and power
- Time-stamped alarms and events
- Circuit breaker condition data with real-time counter and values
- Changes in load levels

With more sensing technologies becoming available, the circuit breaker itself becomes more digitalized and can provide more accurate information about its condition. Moreover, collection and monitoring of data from other switchgear assembly components and sensors – such as earthing switches, disconnectors and door lock position indicators – provides further insights into the electrical and mechanical status of the assembly without the need to be present in the switch room, thus enhancing overall safety for the operation and maintenance teams.



04

Thermal aspects
With MV and LV switchgear section or panel condition monitoring, temperature and humidity data can be collected from the switch room and inside the switchgear →03 – 04. This data provides an understanding of the operating conditions and their potential impact on the switchgear over its lifetime. Further, constant monitoring of critical electrical connections eliminates manual maintenance tasks and ensures that data is continuously recorded and analyzed. In MV switchgear, monitoring the insulation and partial discharge occurrences provides even more information.

—

The user has the option to connect to on-site systems or cloud-based solutions for maintenance management.

LV switchgear is mainly used to distribute energy to hundreds of loads such as motors or sub-distribution panels. Located in various areas of a building or plant, LV switchgear is often exposed to temperature and humidity changes and extremes. Although switchgear is designed to cope with these external influences while accommodating a certain level of internal heat generation, extending the demands on the equipment can result in further heat generation. Traditionally, an operator calculates how much extra load can be added without exceeding the thermal and electrical capacity of the switchgear under the expected ambient temperature and humidity conditions. This undertaking is prone to error. However, digital switchgear can provide valuable historical and current data to help operators and planners make the right decisions for extension planning.

Monitoring LV digital switchgear modules
LV switchgear also has various types of modules that feed motors or external loads. This is another area where maintenance, although regularly required, is sometimes overlooked. For example, removable modules use specially designed contact systems for power connections that withstand a certain number of operations. These contact systems require maintenance such as greasing, which is traditionally conducted in maintenance cycles that may not align with the actual maintenance needs of the component. For this example and other situations, data relating to a digital switchgear module can be provided by smart devices such as a power meter and motor controller. This equipment monitors

— 04 Low-voltage switchgear

— 05 A hybrid edge/cloud approach gives users the best of both worlds: low-latency, fast local processing and advanced, deep processing at a remote site equipped with massive computing power.

various parameters to better understand conditions. Maintenance cycles can be calculated and maintenance effort is minimized by working only on those modules in need, avoiding total switchgear shutdowns.

Motor controllers

Smart LV motor controllers comprise another group of devices whose digital capabilities are often underutilized. While the primary function of these devices is motor control and protection, they are capable of collecting additional valuable data, such as:

- Motor current levels and imbalances
- Thermal loading levels
- Operating and condition data
- Temperature, humidity and other data using additional sensors.

Abnormal motor current levels and imbalances can indicate issues with a motor or connected machine. With this data, the user can go beyond switchgear monitoring and monitor the complete power train.

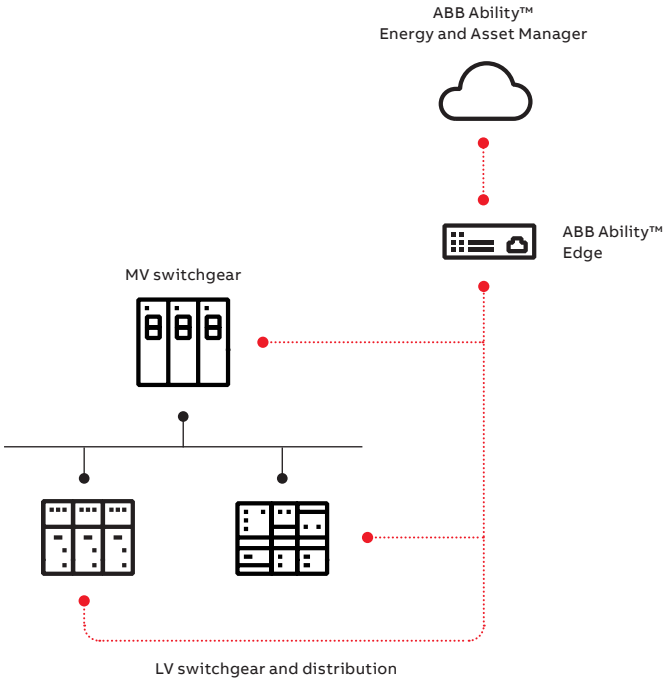
To the edge and beyond

For digital switchgear to deliver its many benefits to electrical systems, careful analysis of the data generated and collected is required. Any analysis on-premise is generally limited to local data, while situations and experiences from other sites are not considered. Should all the data be sent to a data center (ie, the cloud) for further analytics, machine learning and the application of artificial intelligence? Not necessarily. Data may also be processed in real-time on a local computer, server, or even the device that collects it – so-called edge computing.

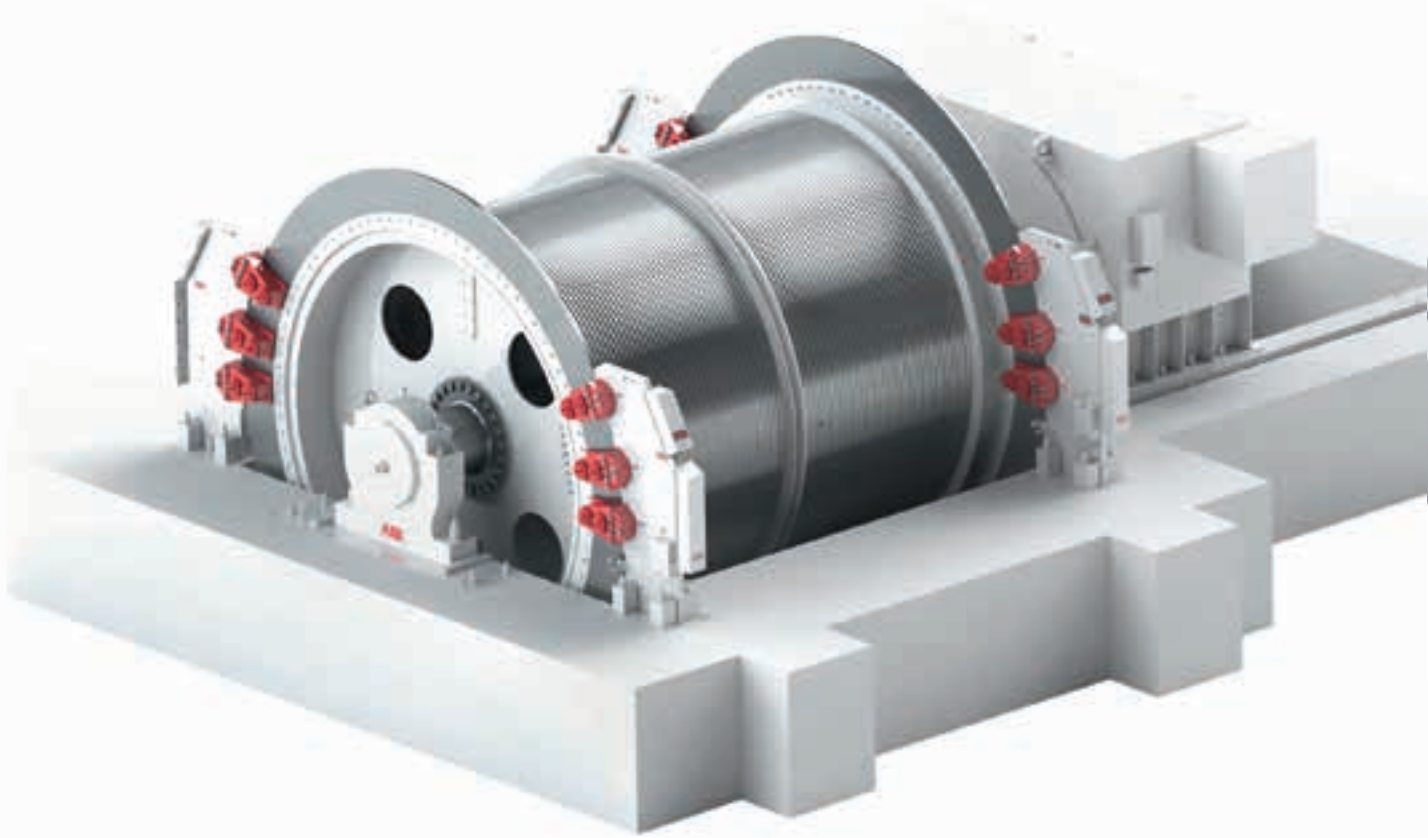
ABB Ability gives the best of both worlds. ABB Ability is a set of ABB industrial solutions that use digital technology. ABB is digitalizing its complete range of products and services and uses a cloud-based platform built on technology from Microsoft Azure to offer a broad range of analytics and services →05. Because ABB Ability solutions are also installed on edge devices, the user has the option to connect to on-site systems or cloud-based solutions for maintenance management.

Many users of digital switchgear adopt edge computing as a crucial part of their hybrid data architecture.

An edge device is relatively inexpensive to install and operate while still providing a suitable level of on-site calculation power and data storage, making it an effective solution whether used solely on-premise or connected to the cloud. Many users of digital switchgear adopt edge computing as a crucial part of their hybrid data architecture thanks to its ability to vastly reduce latency, reduce the need for data centers and cut down on costly bandwidth requirements. And with connectivity to ABB Ability cloud-based solutions, the user can extend predictive capabilities that help understand probabilities of failure across multiple sites and switchgear, enabling further operational cost reduction while making switchgear capable for the future needs of Industry 4.0. •



05



CARRYING MINERS AND MATERIALS TO BETTER DECISIONS ON SAFETY

Going up

More and more mining companies, as well as a number of regional and national governments, are deciding to maximize the safety of their resource extraction operations. In view of this trend, the quality and reliability of mine hoists, the powerful elevator-like systems that transport rock and personnel from deep mines to the surface, have become a fundamental consideration.

ABB, one of the world's largest suppliers of complete mine hoists, and the only company that manufactures and supplies both associated electrical and mechanical systems, has introduced a newly developed platform of mine hoist safety products. Known as ABB Ability™ Safety Plus for hoists [1], the platform is composed of three solutions: Safety Plus Hoist Monitor (SPHM), Safety Plus Hoist Protector (SPHP), and Safety Plus Brake System (SPBS), which includes Safety Brake Hydraulics (SBH).

Mine hoist brake systems are the most safety-critical sub-components of a mine hoist. With this in mind, ABB designed SPBS to include both hydraulic and PLC-based Safety Integrity Level (SIL) 3 brake control sub-systems, thus ensuring seamless integration while maximizing the performance of the complete brake system. In order to be assigned a SIL rating, a hoist control and safety system needs to be designed from the ground up according to IEC62061 functional safety standards. For more on SIL, see insert →01.

For completely new ABB mine hoists, the Safety Plus platform can be designed into a system from the start. This means the resulting mine hoist will be fully SIL 3 certified, including the brake system as well as hoist protections.

Safety Plus Brake Systems ensure seamless integration while maximizing the performance of a complete brake system.

Furthermore, enhanced shaft and infrastructure protection, such as shaft gates, cage doors, remote emergency stop buttons, and more, can be provided by SPHP. Of course, the Safety Plus platform can also be implemented on new mine hoists manufactured by other OEMs.

ABB Ability™ Safety Plus for hoists includes a number of advanced self-testing and diagnostic functions that, in the case of degradation of performance of a safety feature, will either correct performance automatically or flag operations and maintenance personnel early on if potential maintenance issues arise. These functions occur automatically and while equipment is in operation, thus reducing downtime for equipment testing.

The platform can also be used to transfer performance data and test results to ABB Ability™ Performance Optimization for hoists →02, an analytics suite. There, field data regarding speed, position, brake pressure, temperature, time, and actuator position, is sensed and subjected to analysis to allow site engineers to identify discrepancies and take remedial actions.

Tim Gartner
Hoisting Electrical
Montreal, Canada

tim.gartner@ca.abb.com

Magnus Uddman
Advanced Services
Västeräs, Sweden

magnus.x.uddman@se.abb.com

SIL IN A NUTSHELL

SIL (Safety Integrity Level) is a term used by International Functional Safety Standards including IEC61508 and IEC62061. Simply put, it quantifies the relative safety of a system with a unitless number ranging from 1 to 4. The higher the number (SIL level), the higher the level of safety. ABB Ability™ Safety Plus for hoists uses SIL 3 components in all instances where they are available. These components include PLCs, encoders, relays, switches, etc. and since they are SIL 3-rated, they are generally more reliable and come with published reliability data.

The higher the level of safety integrity, the lower the probability that the safety-related system will fail to carry out its required safety functions. At the component level, more and more electrical/electronic components, such as PLCs, speed encoders, switches, relays, etc. are available at SIL 2 and SIL 3 levels, meaning that these subcomponents provide the highest level of hardware safety and reliability available.

01

01 A system's SIL level quantifies its relative safety. The higher the number, the higher the level of safety.

The first fully SIL 3-independently certified platform for mine hoist solutions, ABB Ability™ Safety Plus for hoists offers a range of customer benefits, including best-in-class reliability, and easy (plug and play) integration into existing hoist systems →03.

Redefining mine hoist control and automation
In addition, seamlessly integrated with ABB Ability™ Safety Plus for hoists, as well as ABB Ability™ Performance Optimization for hoists, is the soon-to-be-released, ABB Ability™ NGX Hoist Control Platform.

Designed to comply with all regional- and country-based mine hoist regulations and legislation, the new NGX platform will help large, global mining clients because, regardless of their location, the hoist control system delivered by ABB will be the same, thus providing numerous operational and maintenance advantages.

The design of the new platform builds on years of ABB experience and expertise in designing mine hoist control systems. In addition to providing the highest level of standard hoist control functionality, the modular features of NGX provide a platform for optional performance-enhancing software applications →04, including:

- Demand Driven Control
- Automatic Rope Oscillation Control
- Automatic Controlled Rollback.

ABB's Safety Plus for hoists is the first fully SIL 3-independently certified platform for mine hoist solutions.

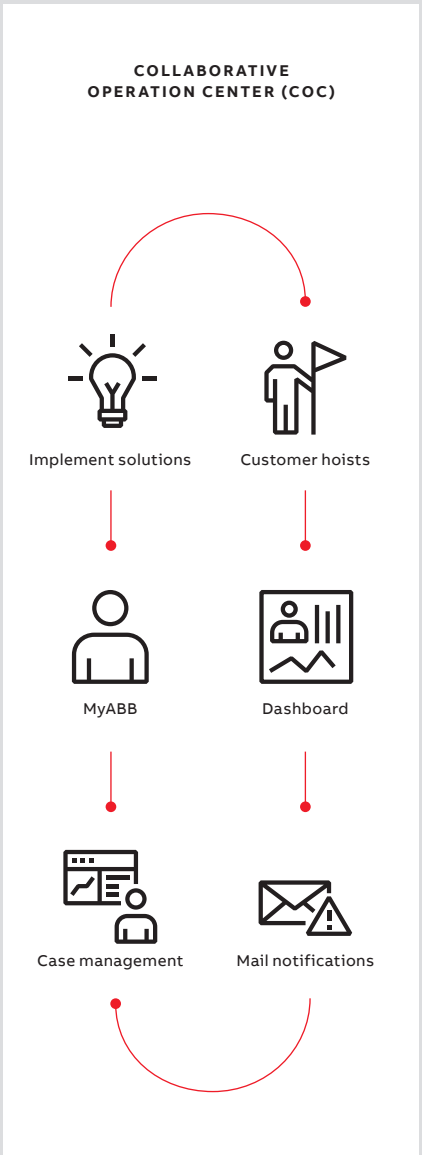
As new mine hoist performance-enhancing software applications are developed, they can be easily integrated with the NGX Platform.

A second advantage associated with its modular features is that the NGX platform can be economically installed on mine hoists ranging from the smallest to the largest. It is also designed for use on all mine hoist types, such as friction, drum, and Blair multi-rope hoists, and can be operated in conjunction with all mine hoist applications, such as service, production, auxiliary or shaft sinking.

Last but not least, the NGX Hoist Control Platform uses ABB's latest PLC and HMI systems

02 ABB's Safety Plus platform for hoists can be used to transfer performance data and test results to an analytics suite.

02a



02b

02

—
02a ABB Ability™ Performance Optimization for hoists provides agile and secure remote support worldwide.

—
02b Thanks to the COC, customers can follow ABB actions as they happen, collaborate, and learn from events onsite or remotely.

—
02c The backbone of ABB Ability™ Performance Optimization for hoists is a cyber secure infrastructure.

—

REMOTE SUPPORT FOR HOISTS WORLDWIDE

ABB Ability™ Performance Optimization for hoists is a digital service designed to improve the uptime, availability, performance, and productivity of mine hoists by providing actionable information on key performance indicators (KPIs) →02a. Hosted on the ABB Ability™ Edgenius Dashboard application [2] – a cloud-based solution that offers a digitized way of working with reports while enhancing transparency – it enables quick analysis and insights into any plant's operation.

The dashboard shows crucial, customer-requested information from hoists with KPIs organized into the categories of performance, supervision, and safety. Additionally, the platform is flexible, scalable and meets the highest levels of cybersecurity.

Predictive analysis of a mine hoist's condition prevents unexpected, time-consuming and costly shutdowns, and opens the door to uninterrupted condition-based monitoring. Data is automatically collected, categorized, and managed, then securely monitored and analyzed to generate actionable insights that can increase production performance, identify safety hazards, and provide optimized maintenance scheduling.

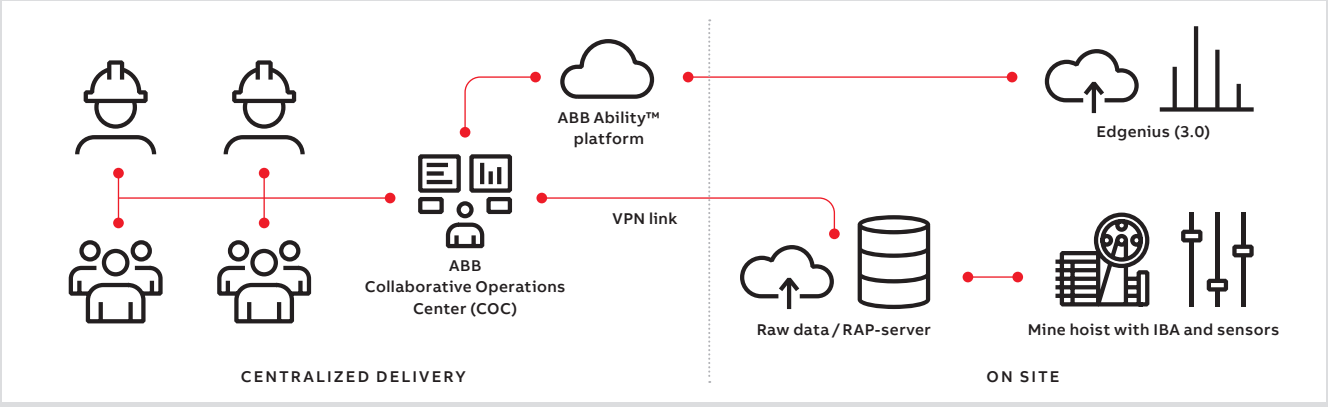
ABB's Performance Optimization service connects customers' mine hoists enterprise-wide with experts located remotely in ABB's Collaborative Operations Centers →02b [3], or on site. Mine hoists are monitored 24/7, meaning that potential problems are identified before they can cause damage, and necessary actions can be taken at the right time. This improves the availability of equipment and the overall safety of mining operations.

The ABB Ability Edgenius Dashboard is available and secured within the ABB Ability™ cloud. Customers can follow ABB actions as they happen, collaborate, and learn from events onsite or remotely. This reduces the requirement for in-person maintenance visits and travel, saving time and lowering ABB's carbon footprint.

The Dashboard creates a cyber-secure bridge between a mine hoist customer's information technology (IT) and operational technology (OT) elements. This helps to establish an increasingly connected infrastructure, more collaborative relationships, and greater transparency in terms of real-time data reporting and actions.

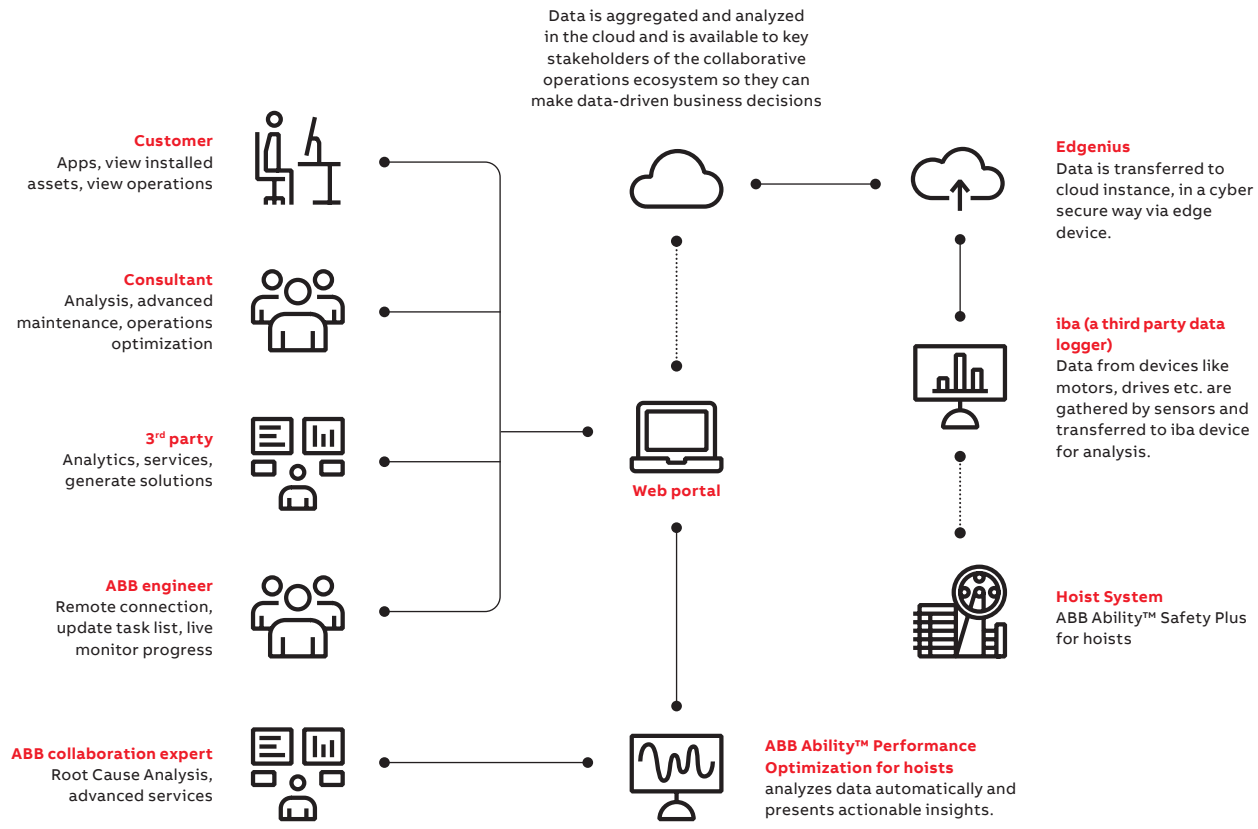
The backbone of this service is in its infrastructure →02c, where all data transferred to and from site is handled in the most cyber secure way. Fault tracing and solution investigation are possible only through a secure VPN connection. The raw hoist data is stored on the premises, where it is easily accessible for both customer and ABB experts for deeper analysis if needed.

Furthermore, ABB Ability Performance Optimization for hoists improves accessibility, performance, and productivity for mine hoists by collecting and analyzing data from various operating points and KPIs, such as mine hoist cycle time, filling and dumping time, as well as the safety brake system and supervision of hoist protections. The results can be used as a basis for optimizing the hoist's availability, which can offer opportunities for further increasing production.



02c

03



04

05

—
03 Mining companies are increasingly turning to technologies that maximize the safety of their resource extraction operations.

—
04 ABB Ability™ Safety Plus Performance Optimization for hoists forms a data-rich environment that benefits all users.

—
05 The NGX Hoist Operator Station provides operators with intuitive and easy-to-understand menus.

and technology. Its operator stations →05 and graphical screens are based on human factors engineering concepts, thus providing hoist operators with intuitive and easy-to-understand menus and graphic screens for the operation and control of mine hoists.

All in all, ABB mine hoist solutions can provide the lowest possible life cycle cost, the highest possible reliability and system availability, short project execution time, and a single source of supply for complete systems, including service and spare parts.

The modular features of the new NGX platform open the door to optional performance-enhancing software applications.

ABB has more than 130 years of experience in hoisting and more than 1,000 hoisting solutions installed worldwide. Digitally connected with ABB Ability Performance Optimization for hoists, ABB hoisting solutions provide the highest availability and productivity. •

—
References

[1] ABB Ability™ Safety Plus for hoists portfolio. Available: new.abb.com/mining/underground-mining/mine-hoist-systems/abb-ability-safety-plus-for-hoists [Accessed January 18, 2022].

[2] ABB Ability™ Edgenius dashboard application. Available: https://new.abb.com/process-automation/edgenius/abb-ability-edgenius-dashboard-visualize-your-needs-and-realize-your-opportunities [Accessed January 18 2022].

[3] ABB Ability™ collaborative operations for mining. Available: https://new.abb.com/mining/digital-transformation-in-mining-industry/abb-ability-collaborative-operations [Accessed January 18, 2022].

BETTER DECISIONS WITH ABB ABILITY™ GENIX ASSET PERFORMANCE MANAGEMENT SUITE

Asset performance management

Multiple pressures drive the need for improved industrial asset productivity, predictability and life cycles. ABB's new asset performance management (APM) suite takes advantage of cutting-edge analytics and artificial intelligence (AI) embedded in the ABB Ability™ Genix Suite to meet these needs.

Narasimham Parimi
ABB Process Automation
Bangalore, India

Narasimham.Parimi@in.abb.com

Christian Johansson
ABB Process Automation
Malmö, Sweden

christian.johansson@se.abb.com

The world of industrial production is experiencing significant fluctuation as popular just-in-time practices prove unable to address supply chain challenges in pandemic-impacted economies. Furthermore, increasing efforts to lower carbon emissions are affecting every aspect of industrial production.

Fundamental to improving production predictability, meeting sustainability targets and achieving other strategic outcomes are the production assets themselves. How these assets perform

—

APM is an important and essential practice for industrial producers, power generators, water purifiers and cargo transporters.

dictate if customer demand is met, if needed goods such as power, food, water and medicine get to the people who need them, if a production facility continues to be a "going concern" and if the enterprise itself survives.

All these factors make strong asset management critical. In today's fast-moving, digitalized, 24/7 production environment, keeping assets performing, avoiding unplanned downtime due to asset failure and extending asset life as much as possible makes APM an important and essential practice for industrial producers, power generators, water purifiers and cargo transporters.

To get the best out of their assets, owners and operators must not only perform condition monitoring, but also attain a complete view of the asset from performance, maintenance, reliability and integrity aspects. The parties concerned also need to develop optimal strategies that minimize asset failures and maximize asset life.

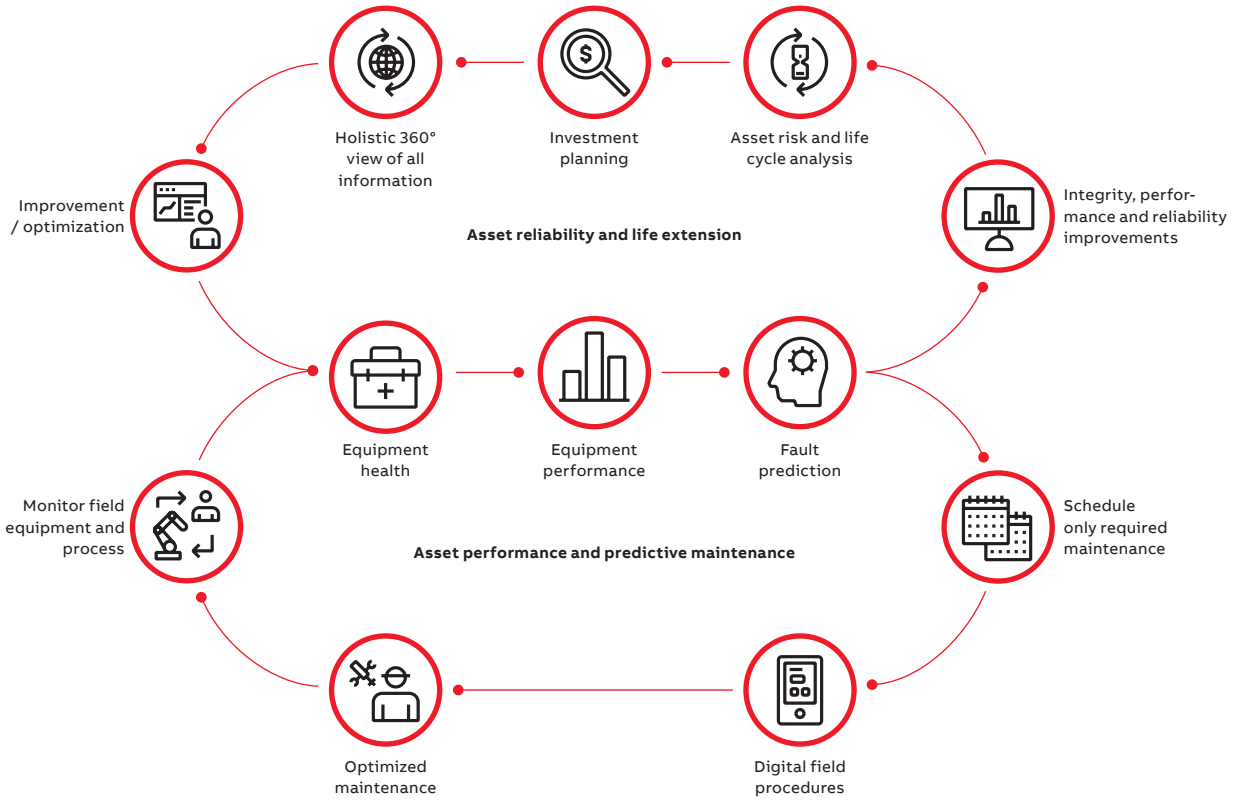
ABB has introduced the ABB Ability Genix APM Suite with a view to help customers achieve these goals →01.

ABB Ability Genix APM Suite

Maintenance and reliability practitioners have long focused on condition monitoring of assets to make operational and maintenance decisions. Rapidly changing market dynamics demand a more comprehensive, integrated view of asset performance, integrity and reliability in order to attain maximum productivity. The journey from individual point solutions to a comprehensive suite of APM solutions is empowered by the Industrial Internet of Things (IIoT), cloud connectivity, "Big Data" analytics and AI algorithms that

—
01 ABB's APM Suite improves industrial asset productivity, predictability and lifetimes.

01



02

APM Predict	Perform 360	Predict 360	Assess 360
Real-time insights into asset conditions using prebuilt asset models	Single source for data and insights relating to asset performance, health and maintenance	Asset models that predict faults and provide recommendations to reduce unplanned downtime	Predict asset life to better plan engineering work and expenditure to maintain production

03

help to identify data trends and automatically take actions to maximize asset efficiency and value.

The ABB Ability Genix APM Suite consolidates a portfolio of previous condition monitoring offerings from ABB into a new, pan-industry, future-proof platform that is agnostic with regards to

—

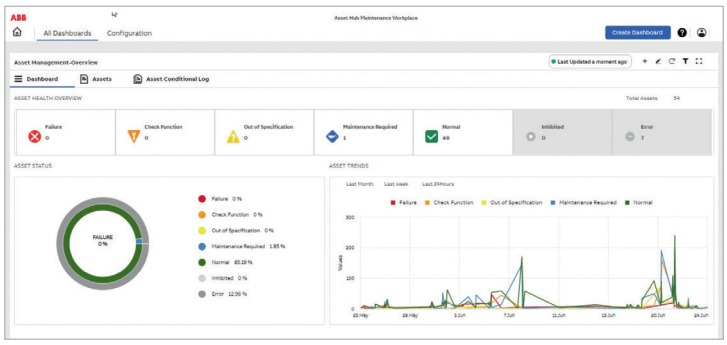
Owners and operators must attain a complete view of the asset from performance, maintenance, reliability and integrity aspects.

the original equipment manufacturer (OEM). Genix APM enables users to evolve from reactive and preventive maintenance to predictive and prescriptive maintenance. Genix APM also allows users to choose in advance how they want to manage asset life cycles (eg, extend maintenance frequencies, or calculate replacement schedules). The suite further helps users to discover hidden interdependencies that can be harnessed to optimize productivity →02.

Genix APM accomplishes this by collecting, contextualizing and analyzing data from multiple sources, and providing the software tools to perform the most useful asset interactions.

The suite is composed of several modules →03:

ABB Ability Genix APM Predict
APM Predict is a fully integrated condition monitoring system that gathers data from plant assets and process equipment, and analyzes that data through prebuilt asset models that identify early indicators of asset degradation and track degradation progress. The early recognition and tracking of asset health predictive indicators by APM Predict helps operators make the transition from wasteful preventative maintenance activities to an optimized predictive maintenance



04

—
02 Genix APM – addressing tactical and strategic needs of customers.

—
03 ABB Ability Genix APM suite.

—
04 APM Predict: real-time condition monitoring on the edge.

strategy. APM Predict provides near real-time, status-based condition monitoring on the “edge” of the cloud. APM Predict:

- Is easy to add into an existing operational technology (OT) landscape, where it runs as a native application on the edge, thus providing connectivity to, for example, ABB Extended Automation System 800xA Publisher, ABB Symphony Plus publisher, OPC UA servers, or Modbus TCP devices.
- Comes with prebuilt asset models covering a wide range of assets that address ABB offerings and target industries. These models include assets that range from simple sensors and field instruments up to complex electrical, rotating and process equipment.
- Features an easy-to-use maintenance workplace interface in which the user can see condition notifications and recommendations, as well as organize and understand assets across plant areas, sites, or fleets of assets.
- Displays electrical assets in the electrical context via a single-line diagram viewer.

Asset condition information is provided according to NAMUR NE107 (a field device data standard), or according to an asset health severity scoring. It is possible to group and organize asset models, assign a criticality to different task models and provide a calculated view of the overall health of an asset →04.

ABB Ability Genix APM Predict
Predict 360 extends the power of predictive asset models from prebuilt versions to customizable versions specific to an industrial operation. Predict 360 provides an environment for asset subject matter experts and data scientists to continuously capture and codify their knowledge into ABB Ability Genix APM, which helps automate diagnostic activities, reveal latent asset and process issues, and discover opportunities for higher production efficiency and asset utilization. Predict 360 helps in advanced fault prediction, increasing uptime and preventing failures of critical assets. The module comes with a configurable asset model library that has prebuilt dominant failure modes. Predict 360 is a self-service application that allows any authorized person to set and configure rules – or AI and machine learning (ML) algorithms – to enable predictive maintenance →05. It also has a comprehensive workplace for asset fault monitoring with recommendations.

Predict 360 provides users, such as data scientists, with advanced modeling capabilities that can be leveraged to expand the basic models of APM Predict into first-principle and ML models. In addition to these advanced modeling capabilities, Predict 360 provides an environment for clients to embed enterprise knowledge and capture tribal knowledge.

One modeling concept that is gaining prominence is the digital twin. A digital twin provides an essential replica of a physical asset, system or process in digital form, enabling intervention before problems occur [1]. Digital twins embody deep domain experience and apply physics-based

—
Genix APM enables users to evolve from reactive and preventive maintenance to predictive and prescriptive maintenance.

or AI/ML models to the behavior they capture. It is within Predict 360 that digital twins are created to help predict failure and eliminate the changes that happen in the “black boxes” into which operatives normally cannot see.

ABB Ability Genix APM Perform 360
Perform 360 epitomizes the ability to gain greater asset insight by performing analytics on a combined OT and IT dataset. Perform 360 integrates the contextualized data of plant IT systems, such as an existing computerized maintenance management system (CMMS), with OT data streaming from APM Predict modules. This provides plant reliability experts with a deeper event perspective as well as a means to monetize different maintenance options, consider impacts of planned maintenance schedules and devise a means to extend intervention intervals and asset longevity. Perform 360 provides insights across asset performance, health, maintenance and life-cycle costs. To

Predict 360 extends the power of predictive asset models to customizable versions specific to an industrial operation.

simplify deployment, Perform 360 comes with more than 40 out-of-the-box asset templates with prebuilt performance models and an array of embedded calculations →06.

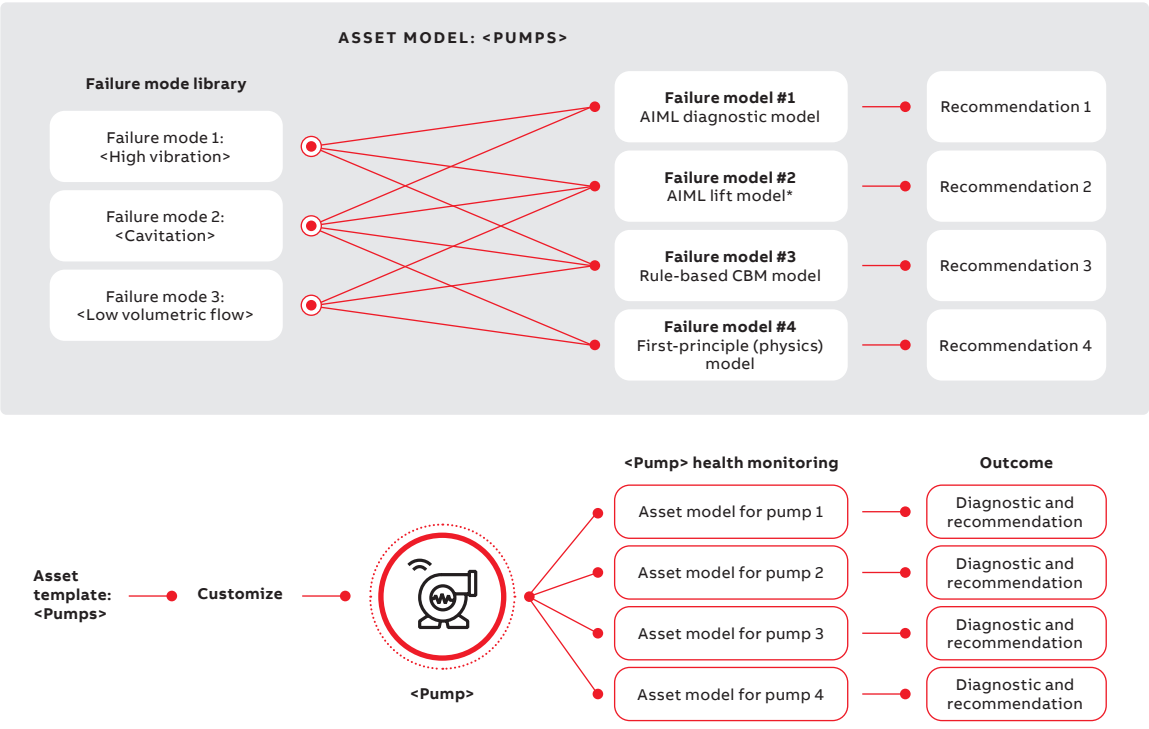
It is also possible to assign different types of alarm and integrity operating window limits and track these from dashboards in the Performance Monitoring Workplace. Compliance can also be tracked.

The value of Perform 360 lies in its use of preconfiguration to make effective deployment simple. The module leverages preconfigured key performance indicators (KPIs) with self-service analytics, including computerized maintenance management system data, and aids decision making through insights into maintenance compliance, failure and damage statistics, life cycle costs and replacement schedules. Perform 360 can also find assets that are mapped using the asset templates and immediately view the prebuilt parameters and KPIs in various dashboards. The module leverages the Knowledge Services Hub of the Genix Suite to calculate these KPIs and deliver insights to the user's browser.

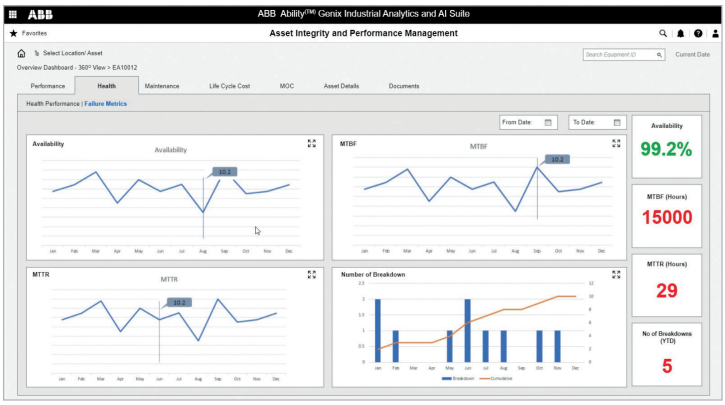
ABB Ability Genix APM Assess 360

Assess 360 provides the tools that traditional APM systems miss: the ability to mine the integrated IT/OT dataset and perform financial data analysis toward optimized asset OPEX and CAPEX planning. Assess 360 helps ensure that short- and long-term asset investments deliver the greatest financial outcomes to business income statements and balance sheets. Assess 360 provides a 360-degree view of assets in terms of performance in order to optimize capital and operational expenditures. This overview helps the operations manager, maintenance specialist or asset owner to understand remaining asset life and maintenance needs →07.

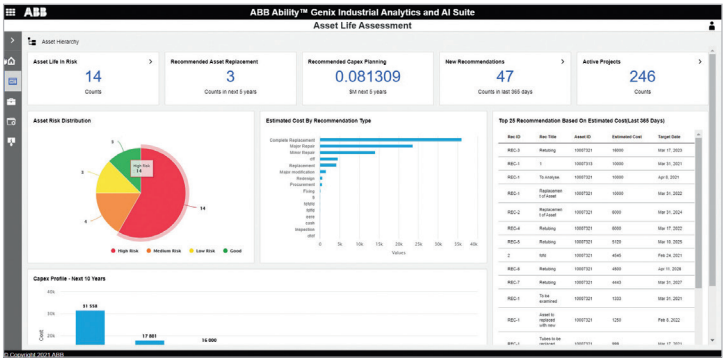
Asset life assessment is a very important focus for organizations with old or aging assets. Such an assessment enables the characterization and understanding of possible failure scenarios. With Assess 360, potential failure mechanisms can be defined, providing the necessary information for mitigation. Further, integrity parameters can be tracked and the qualitative risk of certain failure



AIML: artificial intelligence/machine learning
CBM: condition-based maintenance
*A lift model measures the effectiveness of a predictive model



06



07

—

05 Predict 360: Asset models definition illustration: Pump.

—

06 Perform 360: Insights across performance, health, maintenance schedules and asset life cycle cost. Shown are charts for failure metrics.

—

07 Assess 360: Understand remaining asset life and maintenance needs.

scenarios according to different risk categories can be analyzed to forecast an optimum blend of maintenance or replacement. This capability makes sophisticated maintenance approaches such as Reliability-Centered Maintenance possible.

Genix Datalyzer

The ABB Ability™ Genix Industrial Analytics and AI Suite is a platform upon which many digitalization applications may be built to meet various customer needs. For example, an emerging Genix Sustainability Suite addresses the increasing environmental compliance pressures imposed by governments and includes an industrial data analytics offering for ABB's emissions monitoring systems. This offering is known as the ABB Ability™ Genix Datalyzer. Emissions monitoring is a significant pressure point for businesses and is becoming even more so with the world's focus on sustainable production. The Datalyzer's emission reports are needed by ABB customers to prove environmental compliance, as compliance requires a record of regular equipment inspections and calibration, which Datalyzer tracks cost-effectively in a remote-enabled way.

Genix – a software suite for APM and more

The Genix APM Suite delivers significant improvements in operations by estimating the remaining useful life of assets and providing a maintenance plan that can reduce asset downtime by up to 50 percent and increase asset life by up to 40 percent [2]. Customers in asset-intensive industries – energy, manufacturing, marine, process or utility – can benefit significantly from the ABB Ability Genix APM Suite. Genix APM is modular and can be scaled up as the number of assets or production units rise. The Genix APM Suite resolves many of the asset-specific, function-limited aspects of previous-generation asset management technology to maximize uptime and ensure that producers perform optimally in today's rapidly changing world. •

—

Perform 360 integrates the contextualized data of plant IT systems.

—

References

[1] S. Kulkarni, "The twin that's key to decoding asset DNA." Available: https://new.abb.com/cpm/industrial-software-solutions/asset-performance-management/the-twin-thats-key-to-decoding-asset-system-dna [Accessed: February 18, 2022].

[2] V. Dilda et al., "Manufacturing: Analytics unleashes productivity and profitability." Available: https://www.mckinsey.com/business-functions/operations/our-insights/manufacturing-analytics-unleashes-productivity-and-profitability [Accessed December 17, 2021].

BETTER DECISIONS IN AUTOMATION FOR E-MOBILITY

Supercharging battery production

The automotive industry is gearing up for a future dominated by electric vehicles. ABB Review sat down with B&R's electromobility expert, Ronny Guber, to learn about the important role batteries will play in that future and how B&R automation can significantly improve battery production volumes.

AR Ronny, how does B&R tie into ABB and what is your role in B&R?

RG You'll remember ABB acquired B&R in 2017 to round out the company's automation portfolio. B&R's solutions and services in programmable logic controllers (PLCs), industrial PCs, and servo motion-based machine and factory automation complement ABB's industrial automation offering very well. At B&R, I am the industry segment manager for e-mobility, so our topic for today – the technology for electric-vehicle battery production – falls under my remit.

AR Electric vehicles seem to be taking off now. Is it safe to say the electromobility trend is going strong?

RG Absolutely. The market share of electric vehicles has continued to grow exponentially, even during the global downturn in overall car sales due to the pandemic. Current forecasts predict that by 2036, electric passenger vehicles will surpass internal combustion engine vehicles to make up the majority of all car sales worldwide →01.

AR What's driving that trend?

Title photo: ©navee/stock.adobe.com

Ronny Guber
B&R Industrial Automation GmbH
Eggelsberg, Austria

Ronny Guber is B&R's Industry Manager for E-Mobility. He began his career at B&R as an application engineer and most recently headed the company's sales offices in Regensburg, Germany. He holds a degree in Communications Engineering from the University of Applied Sciences in Leipzig.

RG Consumers are increasingly motivated by sustainability. Many people are ready to make their next car an electric one and their decision hinges on two main factors: price and range. In other words: How much more do I have to pay for an electric car than a conventional one and how far can I go before I need to start looking for a charging station. These happen to be two areas where batteries play a decisive role →02.

AR How so?

RG Batteries account for around a third of an electric vehicle's cost, so producing them efficiently will be crucial to making the price tags more attractive for consumers. And to improve vehicle range, you need to get the latest battery technology to market as quickly as possible. You also have to adhere to manufacturing tolerances and cleanroom conditions that are much more sensitive than for traditional car parts.

—

Battery producers need to eliminate stop-and-go traffic between processing stations and achieve much faster cycle times.

AR With electric vehicle sales growing exponentially, will battery production be able to keep up?

RG That's the million-dollar question. And to a large degree, the answer will come down to how well those factories are automated. To reach the necessary capacity and cost efficiency, battery producers will need to eliminate stop-and-go traffic between processing stations and achieve cycle times that are orders of magnitude faster than traditional automotive components. The plants will need to be a continuous blur of high-speed productivity – like a battery production superhighway.

AR And automation technology can make that possible?

RG Yes, that will be the central role of automation technology – particularly intelligent transport systems. These systems allow you to keep the products on the track, so no time is wasted on unnecessary handling. Production can flow

continuously at full speed while processing steps are accomplished in motion. And when you have lightning-fast synchronization with other automation components along the track, you can get dramatic reductions in processing time at each step.

AR Can you put that in numbers?

RG By combining a track system with machine vision, for example, you can identify battery cells in 50 milliseconds as they pass by at 4 meters per second – with no external triggers, lights, or expensive cameras. That would normally take two full seconds with the product stopped, so it's a time savings of 97.5 percent. And there are many other steps in battery cell production, such as tape application, where doing them in motion brings time reductions of up to 90 percent or more.

AR So you increase overall productivity by speeding up the individual steps.

RG Exactly. Not to mention that you eliminate handoffs between transport systems – which would otherwise take nearly a minute for a set of ten cells. When you add up all those seconds and multiply it by the quantities we're talking about, it's an absolute game-changer in terms of parts per minute. But the gains are not just in speed but also in density and availability.

AR How so?

RG With an intelligent track system, you can arrange the manufacturing flow as a network of interconnected production stations. That way, you can coordinate cycle times and have fewer stations, with better utilization at each one. You can eliminate buffers and empty stretches of conveyor that take up space without adding value. By operating slower stations in parallel, you can multiply productivity without multiplying the footprint. With a networked production flow, parts are rerouted automatically around a faulty station, so small interruptions no longer have such an outsized impact on overall equipment effectiveness the way they do with a traditional linear setup.

AR What does that mean for battery production?

RG With numbers like seven times the output per line, we're seeing manufacturers replace four conventional lines with one high-speed line – that's a 75 percent reduction in floorspace. Or, to put it another way, if you have a factory that's two or three times as fast, it's basically like having two or three factories. Ultimately, what that means for battery production is a really outstanding return on investment.

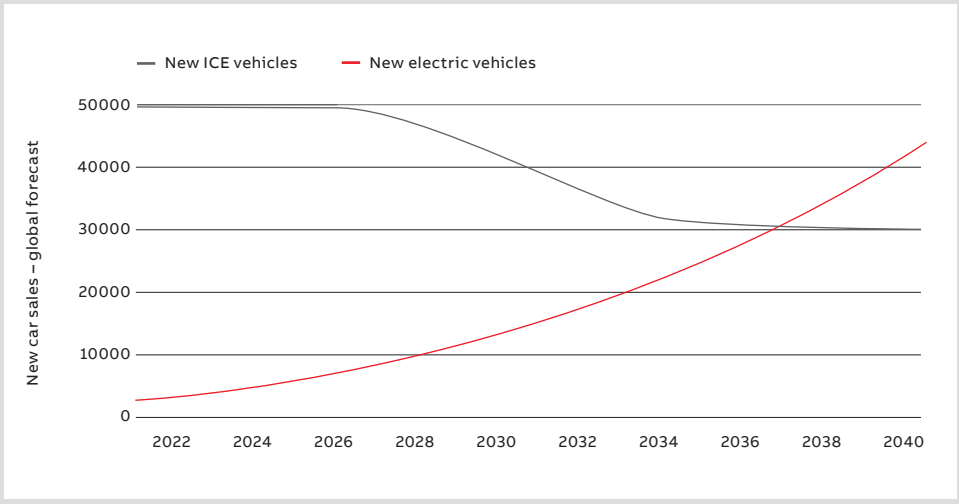
AR Does B&R offer such intelligent track systems that speed the flow of production?

RG Indeed we do. We have, for example, SuperTrak and ACOPOStrak [2]. The latter's revolutionary design enables adaptive manufacturing systems and promises a new era in flexible and efficient production. ACOPOStrak's electronic diverter is – quite literally – a pivotal component of the system as it lets product flows diverge and converge and allows the shuttles that carry the product components to switch tracks at full speed with no compromise in productivity →03. ACOPOStrak and its diverters are easy to reconfigure as, for example, battery component production requirements change. They also add a new dimension of flexibility for implementing parallel processing, which is a critical aspect of speeding up battery cell production lines.

By operating slower stations in parallel, you can multiply productivity without multiplying the footprint.

AR I heard that one of B&R's intelligent production systems uses magnetic levitation!

RG Yes, it does! This is ACOPOS 6D, where shuttles with integrated permanent magnets levitate smoothly over the surface of electromagnetic motor segments, carrying production parts [3]

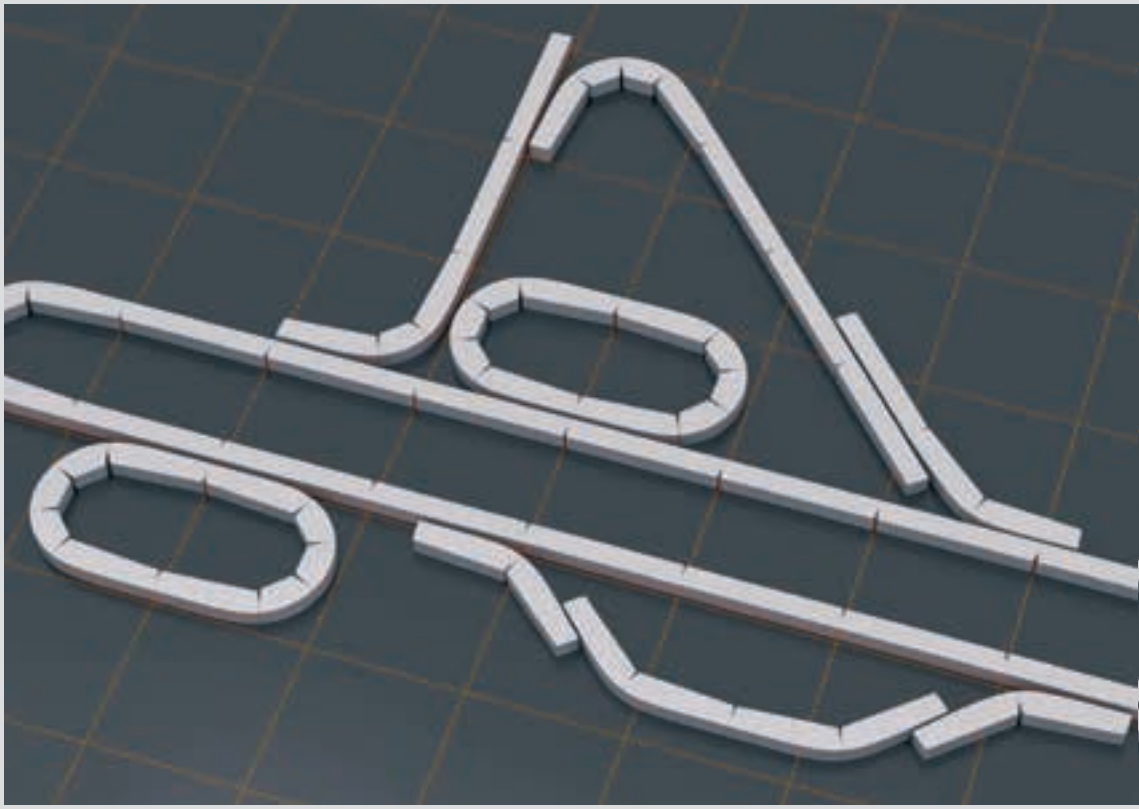


—
01 Forecasts predict that by 2036, electric passenger vehicles will surpass internal combustion engine (ICE) vehicles to make up the majority of new car sales worldwide [1].

—
02 Battery cost and capability are important considerations for those thinking of purchasing an electric vehicle.

01

02



03

→04. These segments can be arranged in any configuration and the shuttles can carry up to 14.4 kg. Because magnetic levitation eliminates contact and, with it, abrasion and particle shedding, ACOPOS 6D is great for the cleanroom conditions needed for battery production. ACOPOS 6D and track systems like ACOPOStrak and SuperTrak complement each other and will be used together in many applications. Both

—

It's especially important to have simulation-based development, testing and virtual commissioning tools.

ACOPOStrak and ACOPOS 6D can be used for the production of batteries and battery components, but B&R has plenty of other production technology to help attain the productivity needed to meet the huge demand for batteries that will come with the mass adoption of electric vehicles.

AR You also mentioned the importance of time to market, can automation technology help there as well?

RG Absolutely. Since we're discussing designing a whole new battery production system, it's especially important to have tools for simulation-based development, testing and virtual commissioning. That way, you can compare layouts and forecast throughput long before any hardware is involved. The sooner you know what to expect, the better. Then you can move rapidly from conceptual design to deploying an optimized system without risking expensive delays and redesigns.

AR And in terms of software development time?

RG When your goal is to ramp up production as quickly as possible, you need multiple development teams working in tandem. So it's a huge benefit to have a universal engineering environment that supports concurrent development. And if those developers can set up basic machine functions with out-of-the-box software components, they're able to focus their time and energy on implementing the processes that are unique to battery production.

AR Sounds like quite an exciting road ahead for the automotive industry.

RG That's for sure. And what we've talked about so far has mainly focused on the production of

04

—
03 ACOPOStrak allows the fast and flexible creation of high-speed production layouts.

—
04 With ACOPOS 6D, magnetically levitated shuttles move production components around at high speed.

individual battery cells. There will be even more opportunities for optimization as cell production moves closer together with the assembly of cells into packs and integration into the car. All signs say that's the way things are headed – and with B&R's full portfolio of integrated automation technology, combined with robotics and ABB automated guided vehicle expertise, we're ready to start making that future a reality today.

AR Ronny, thank you very much for the interview. •

—
References

[1] Ultima, in partnership with ABB, "Electric Vehicle Supply Chain Analysis. How Battery Demand and Production are Reshaping the Automotive Industry," March 2021. Available: https://new.abb.com/docs/librariesprovider89/default-document-library/automotive-battery-supply-chain-analysis-2021-final_abb_ams---abridged-version-docx.pdf?sfvrsn=3bc9f708_2 [Accessed 15 November, 2021].

[2] C. Klingler-Deiseroth, "Intelligent transport for production lines," *ABB Review 2/2018*, pp. 68–73.

[3] D. Rovelli, "ACOPOS 6D heralds a new era of productivity," *ABB Review 4/2021*, pp. 10–15.

BETTER DECISIONS FOR ENERGY MANAGEMENT WITH ABB ABILITY™ ENERGY MANAGER

Smart energy management

Fabio Monachesi
ABB Electrification
Bergamo, Italy

Fabio.monachesi@
it.abb.com

Michela Zambetti
ABB Electrification
Bergamo, Italy

michela.zambetti1@
it.abb.com

Aggressive energy standards and new initiatives tightly regulating sustainability reporting are advancing in tandem with the digitalization revolution. The result is real-time data-driven energy management solutions.

With its vast number of electric assets and around-the-clock energy requirements, the industrial sector is the global energy management market value leader – valued at an estimated USD 12.3 billion in 2021, it is forecasted to grow and reach USD 17.4 billion by 2030 [1].

Organizations that recognize the significance of energy management, will benefit by visualizing their energy consumption, tracking and reducing it. ABB Ability™ Energy Manager – whether cloud-based or on-site, provides any organization with the ability to do just that.

Defining energy management

"Energy management" viewed as a buzzword, summarizes the competences required to understand energy flows and performance actions necessary for improvement. However, upon examination, this broad term describes smaller, inter-linked functions that are a critical part of a stepwise digitalization transformation.

The ability to gather accurate, real-time data, leveraging digital technologies, supports the implementation of energy management initiatives and enables companies to make faster decisions.

Organizations that recognize the significance of energy management will benefit by visualizing their energy consumption.

ABB designates five functional stages that constitute essential best practices for energy management, where digital tools play a fundamental role: detect, monitor, analyze, optimize and control [2].

Through detection, facility owners and managers use data from utility bills and available building information to benchmark, virtually disaggregating the energy costs to identify areas of excess energy consumption. Large datasets and Artificial Intelligence (AI) algorithms support this process.

Once a benchmark is set, monitoring follows. By leveraging device connectivity to visualize the historical and real-time energy data of key assets, facility owners and managers build a clearer picture of the issues to be resolved. Products, eg, circuit breakers, meters, relays, EV-chargers, inverters and sensors, linked to an on-site connectivity infrastructure or dashboard with widgets, are critical.

Once gathered, data is analyzed – especially for Key Performance Indicators (KPIs) and output reports are created; enabling saving actions aligned with benchmark targets. Energy forecasting analytics make this stage easier and more accurate.

Next, asset setpoint scheduling is used to optimize targeted KPIs. Here, smart connected products, power quality converters, uninterrupted power supplies (UPS), transfer switching and advanced relays, feed into an optimization engine, enabling those charged with delivering energy reductions to improve outcomes.


ABB Ability™
ABB SACE Building
ABB S.p.A. Via Pescaria 5 24123 Bergamo (BG) IT
Manager
11:37
John Smith
Dashboard
Explore
Data analytics
Events
Automation
Maintenance
Settings
Dashboard
Add panel
Overview
Energy
Assets
Real time currents
Asset
Select asset...
All
Favourites
DEVICE IL1 (A) IL2 (A) IL3 (A)
C1 52-A1 288,0 279,0 279,0
C1 52-A3 290,0 279,0 270,0
C1 QF21 160,0 78,0 155,0
C1 QF28 295,0 281,0 271,0
C1 QF35 54,0 51,0 53,0
C1 QF36 0,0 0,0 0,0
C1 QF42 80,0 78,0 85,0
C1 QF43 66,0 52,0 71,0
C1 QF45 0,0 0,0 0,0
C1 52-A1 288,0 279,0 279,0
C1 52-A3 290,0 279,0 270,0
C1 QF21 160,0 78,0 155,0
C1 QF28 295,0 281,0 271,0
C1 QF35 54,0 51,0 53,0
Page 1 / 18
Site locator
ABB S.p.A. | SACE
Power generation
11,25%
Power Generation
Site generator capacity
80,0 Kwp
Generated power
9,0 kW
Group peak monitoring
Group
ABB SACE BUILDING
Period
Today
Show contractual power
Active power
Contractual power
Total Active Power (kW)
Today (24 Feb 2020)
Energy monitoring
Group
ABB SACE BUILDING...
Compare group
ABB SACE BUILDING...
Period
Today
Compare to previous period
Plant
Generator
Energy (kWh)
Today (24 Feb 2020)
Energy (ABB SACE Building - Plant)
212.387,0 kWh
Energy (ABB SACE Building - Test Group 01)
363.780,0 kWh
Power demand
72,25%
Power demand
Contractual power
400,0 kW
Active power
289,0 kW
Power factor
Asset
Lift power supply
Period
Today
Today
0,97
Power Factor
Real time power
Asset
Select asset...
All
Favourites
DEVICE P (KW) Q (KVAR) S (KVA)
C1 52-A1 -185,0 -40,0 -189,27
C1 52-A3 182,0 43,0 187,01
C1 QF21 84,0 23,0 87,09
C1 QF28 186,0 36,0 189,45
C1 QF35 31,0 17,0 35,36
C1 QF36 N.A. N.A. N.A.
C1 QF42 53,0 0,0 53,0
C1 QF43 33,0 25,0 41,4
C1 QF45 N.A. N.A. N.A.
C1 52-A1 -185,0 -40,0 -189,27
C1 52-A3 182,0 43,0 187,01
C1 QF21 84,0 23,0 87,09
C1 QF28 186,0 36,0 189,45
C1 QF35 31,0 17,0 35,36
Page 1 / 18
Real time voltage
Asset
Select asset...
All
Favourites
DEVICE U12 (V) U23 (V) U31 (V)
C1 QF35 393,0 393,0 394,0
C1 QF36 393,0 393,0 394,0
C1 QF42 392,0 391,0 391,0
C1 QF43 393,0 391,0 392,0
C1 QF45 0,0 0,0 0,0
C1 QF49 401,0 339,0 400,0
C1 QF51 0,0 0,0 0,0
C1 QF52 395,0 394,0 394,0
C1 QF53 389,0 389,0 390,0
C1 QF35 393,0 393,0 394,0
C1 QF36 393,0 393,0 394,0
C1 QF42 392,0 391,0 391,0
C1 QF43 393,0 391,0 392,0
C1 QF45 0,0 0,0 0,0
Page 1 / 18
Peak monitoring
Asset
Select asset...
Period
Today
Show contractual power
Active power
Total Active Power (kW)
Today (24 Feb 2020)
Energy cost
Period
Today
GROUP ENERGY (KWH) COST (€)
Group of Conditioning 920,0 276,0
EV Charging TOTAL 0,0 0,0
Conditioning general services 441,0 132,3
Ascensori 4,0 1,2
Conditioning Administrative 479,0 143,7
System TEst Lab 51,0 15,3
Totale 4.826,0 1.448,7
Charges B C D E 0,0 0,0
Plant generetors 175,0 52,3
Group of Conditioning 920,0 276,0
EV Charging TOTAL 0,0 0,0
Conditioning general services 441,0 132,3
Ascensori 4,0 1,2
Conditioning Administrative 479,0 143,7
Page 1 / 18
Analog data monitoring
Asset
B Monitor TR1
Input
3T-1 Current Sensor
Period
Today
Temperature (°C)
Energy mix group
Total facility group
AuditGroup
Subtract group
Test CMS Energy Mix 2
Subtract group
Test CMS Energy Mix
Subtract group
Select Group...
Period
Today
GROUP ENERGY (MWH) ENERGY (%)
Test CMS Energy Mix 2 73 27,05 %
Test CMS Energy Mix 63 23,46 %
Others 134 49,49 %
Total Incomer 270 100 %
Total Incomer
270 MWh

—
01 Screenshot of analyzed data for connected products

With energy management systems and processes in place, control allows the asset setpoint to be carefully adjusted for energy efficiency or service continuity strategies. Pre-engineered reference architectures with Edge controllers and smart connected products, plus on-site distribution energy resources, microgrids, BESS and renewable technologies, should be considered.
By following these stages, organizations can continuously improve energy efficiency practices.

Energy management benefits
With the need to manage and lower energy usage across the industrial landscape more regulated now than ever (the basis for IEC 60364-8-1 and ISO 50001 for Energy Management Systems – Requirements with Guidance for Use) [3], compliance and avoidance of penalties for non-compliance is paramount. Nevertheless, energy management should be embraced, not out of necessity, but because it demonstrates a company's willingness for accountability.

Today's market-leading EMS solutions, such as ABB Ability™ Energy Manager, simplify this process as engineering requirements are minimal and system commissioning is quick (usually within one day). Available as Software-as-a-Service, it is ready-to-use.

Energy management monitoring helps industrial facilities fulfill sustainability targets, thereby reducing CO_2 emissions and unlocking further energy savings more easily than systems without digital capabilities; savings can lead to ISO 50001- and LEED certification.

Additionally, operating expenses (OPEX) can be reduced. Data insights help forecast energy usage, thereby increasing efficiency by up to 30 percent and reducing costs. ABB Ability™ Energy Manager delivers a potential payback in less than three years.

Getting started
Organizations, single- and multi-site facilities, that want to initiate steps toward energy management benefit from a concise assessment of energy usage. Energy service companies (ESCOs) typically perform audits and start creating actionable reports. Enlisting the support of an expert service provider, such as ABB, early on can pay dividends by maximizing energy management rapidly. Usually, all available historical site data is requested, data from facility utility bills, building information systems and field sensors.

ABB's Energy Manager, with add-on and premium service available, has provided valuable data-driven insights to a variety of industrial facilities →01 [1-4]. Recently, ABB Ability™ Energy Manager helped an international food facility

—
ABB Ability™ Energy Manager has helped a variety of international facilities control electricity costs and reduce emissions.

control electricity costs and reduce emissions while maintaining reliability and efficiency. By analyzing energy consumption, production costs could be optimized – the facility could save 30 tons of carbon by making additional use of ABB's EKip digital controllers to deliver power peak shaving [1].

In 2021, ABB initiated an EMS solution for a technology campus with multiple facilities and buildings. By monitoring power equipment in real-time and sending alarms via mobile devices, ABB Ability™ Energy Manager has helped this campus reduce energy consumption by 20 percent. In these ways, ABB demonstrates their ability to help an organization of any size roll out their energy management initiatives and secure their energy and cost targets [1-4]. •

Footnote
[1] Global energy management market size by sector 2025 Statista

—
References

[1] ABB white paper, "The Growing Impact of EMS Solutions", *Guided Insights*, 2021, p. 20.

[2] ABB website, Available: https://new.abb.com/about/our-businesses/electrification/abb-ability/energy-and-asset-manager/abb-ability-energy-manager [Accessed March 21, 2022].

[3] ABB case study website, "State of the art solution for CO_2-neutral and energy self-sufficient factory", Available: https://abb-casestudies.com/#/39 [Accessed March 21, 2022].

[4] ABB case study website, "Largest Swiss rice mill moni-tors energy distribution digitally", Available: https://abb-casestudies.com/#/171 [Accessed March 21, 2022].

BETTER DECISIONS WITH OCTOPUS

Deep data

An ABB ship operations performance package uses motion monitoring to quantify the risk of losing containers due to excessive accelerations in wave conditions.

Jukka Määttänen
ABB Marine & Ports,
Digital Services
Helsinki, Finland

jukka.maattanen@
fi.abb.com

Container ships are not known for their flexibility. But in point of fact, they are not rigid, and a vessel's structure does indeed bend in response to the varying loads on its hull. Though of course imperceptible to human senses, such dynamics can have a significant effect on cargo, particularly container stacks. Furthermore, given that the forces acting on containers in a stack are the result of a ship's responses to prevailing conditions, the ability to monitor and predict vessel motions offers a self-evident safety benefit for containerships.

Then again, if limited to a single location, the accuracy of vessel motion measurements is limited. Accuracy levels improve significantly, however, when accelerations are measured at a minimum of three locations that are widely distributed over a vessel. This, in essence, is the key concept behind the ABB Ability™ OCTOPUS Marine Advisory System, a ship operations performance management package that uses motion monitoring →01 [1] to quantify the risk of losing containers due to excessive accelerations in wave conditions.

> Protecting cargo against excessive loads is best achieved by using "vessel response forecasting."

Although only a tiny percentage of the six to seven million containers in transit on the water at any given moment, the estimated 1,500 containers that are thought to be lost each year can have significant consequences. Aside from short-term financial costs, reputations are at risk. Environmental impacts can also be a major concern – particularly when the cargo in question is hazardous. Meanwhile, stray containers – whether afloat or on the seabed in shallow waters – represent a potential threat to marine habitats and navigational safety.

Weather forecasts, which include information on sea states, are fundamental to predicting vessel motions and the associated forces exerted on

Title photo: ©enanuchit/stock.adobe.com

cargo. With accurate insights into conditions at sea, shipmasters can avoid areas where vessel motions are likely to be most severe. Simply considering the height of waves may not be sufficient, however, as the distribution of wave periods and wave direction relative to a ship's heading can have a greater impact on acceleration levels than wave height alone.

In view of this, protecting cargo against excessive loads is best achieved by using an automated process known as "vessel response forecasting" in which forecast wave conditions are translated into predicted vessel motions. Knowledge of how a ship responds in different sea states is essential to this process; here, its motions in a range of wave directions, periods and heights are recorded over time – with vessel speed and loading condition also taken into account – and stored in a database. Based on this information, OCTOPUS supports real-time decision-making in voyage planning and execution →02. Indeed, it has accomplished this so successfully that ABB estimates that the system is currently utilized by around 90 percent of the semi-submersible heavy lift ships in operation worldwide.

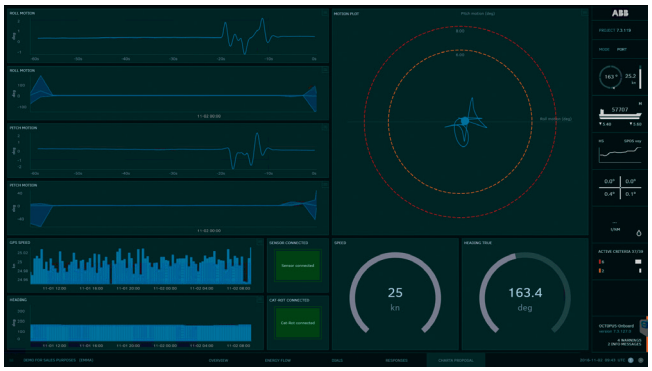
In addition to providing users with detailed information about current conditions, OCTOPUS helps to identify the risks related to vessel motions when changing heading or speed. Motions such as roll and pitch are calculated for the full range of headings and ship speeds and compared with an upper limit. Vessel motion risk management of this type is already a powerful safety tool in the project cargo market, where heavy lift ships transport huge, unwieldy cargoes.

Supporting new wind energy farms

Alongside improved safety, vessel response forecasting based on the OCTOPUS platform also brings efficiency gains. ABB's ship-type specific expertise in hydrodynamics ensures that OCTOPUS capabilities are transferrable across a growing range of vessels, including wind turbine installation vessels, where there is a direct relationship between minimizing vessel motions and maximizing the operational window →03. For example, a forthcoming vessel for Louis Dreyfus Armateurs will leverage OCTOPUS as it serves the world's largest offshore wind farm.

OCTOPUS is also making a key contribution to the far-reaching European Union-backed 'Project ATLANTIS' research initiative, which is designed to develop new wind energy fields in the Atlantic Ocean, two of which are located off the coast of Viana do Castelo, Portugal. A newly developed OCTOPUS module will provide actionable insights to help onshore operators optimize the planning of missions from port to wind farm, cut transfer times between land and wind farms, and reduce vessel waiting time and on-site worktimes.

ABB estimates that OCTOPUS is utilized by 90 percent of the semi-submersible heavy lift ships in operation worldwide.



01

02

—
01 The OCTOPUS Motion Monitoring function helps onboard staff take immediate action when maximum allowable motions and accelerations are exceeded.

—
02 The OCTOPUS user interface. Red, orange and green heading sectors provide assistance in voyage planning, thus minimizing the risk of cargo damage or loss.

—
03 ABB's OCTOPUS software will cut the transfer times between land and wind farms for installation vessels.

The new module will also take into consideration the operational limitations of associated ships and personnel and assess deployment opportunities for remotely operated underwater vehicles (ROVs), unmanned surface vehicles and unmanned aerial vehicles. This is an industry first as it allows onshore users to plan offshore operations according to the performance of a vessel, crew and equipment in the actual conditions they face. It is also a significant step forward for remote decision-making: in adverse weather or rough seas, a mission or an ROV launch could be aborted to save a wasted deployment or worse. All of this adds up to clear benefits for safety as well as efficiency.

—
In an industry first, OCTOPUS will assess deployment opportunities for remotely operated vehicles in its evaluations.

Although the latest addition to the OCTOPUS suite was developed with ATLANTIS in mind, ABB's vision is to develop the module to serve multiple sectors, such as the cruise industry, where it could be used to plan short routes, and the offshore oil and gas industry, where it could map supply operations for rigs and floating offshore units. •

03

—
References

[1] ABB. ABB's OCTOPUS advisory system predicts safer, more efficient ship performance. Available at: https://new.abb.com/news/detail/76792/abbs-octopus-advisory-system-predicts-safer-more-efficient-ship-performance [Accessed October 10, 2021].

BETTER DECISIONS FOR SMART CITIES

Integrated infrastructures

The United Nations estimates that by 2050 almost 70 percent of the world's population will live in urban areas.

—
ABB offers solutions for cities in five key areas: electric grids, water, transport, buildings, and district energy.

In view of this, city planners are scrambling to ensure that growing numbers of people in increasingly dense settings have affordable and equitable access to reliable and sustainable energy, clean water, sanitation, transport systems, and housing.

Particularly in terms of operations and maintenance, these massive infrastructures can benefit significantly from the digitization and optimized lifecycle performance offered to businesses and individuals by ABB Ability™ solutions. Specifically, these solutions are concentrated in five key areas: electric grids, water, transport, buildings, and district energy.

In terms of electric grids, ABB's major areas of expertise are grid connections and power distribution, automation, solutions for integration of renewable energy sources, and energy storage. To meet customer demand in these areas, ABB provides electrical equipment, primary and secondary distribution substations, containerized substations, smart control cabinets, and protection and control devices.

In the water management area, ABB offers solutions that result in up to 25 percent improved water cycle efficiency. These include electrification, automation, and motors and drives for pumping stations, water and wastewater treatment stations, desalination facilities, and technologies designed to protect coastal areas and waterways.

Transporting large numbers of people efficiently, affordably, safely and sustainably is another key challenge for cities. In this connection, one of ABB's major areas of expertise is EV charging, including roadside stations, commercial parking, and asset and fleet management. The company also offers a range of automation and electrification technologies that support electric buses and rail systems, as well as shore-to-ship technologies. These include ship and boat electrification, power solutions for ports, and crane control and motion technologies.

Technologies for buildings are a fourth major area of expertise for ABB, which offers efficient energy management and control systems for residential and commercial buildings, industrial facilities, and data centers. Here, the company offers solutions in areas such as power quality control, UPS and storage, building automation, atmosphere and lighting control systems, metering and submetering, HVAC controls, entry and security systems, as well as a range of smart home technologies.

With regard to data centers – an increasingly important part of urban administration because of their ability to support all other services – ABB offers expert knowledge in areas such as power distribution and protection; cooling systems; building, energy, and automation management; as well as its Secure Edge Data Center (SEDC) for industrial and telecommunications environments.

ABB also provides district heating and cooling as well as management of waste energy. Here, areas of specialization include gas distribution and control, process optimization, and collaborative operations centers. Collectively, these systems can result in up to 30 percent in energy savings. •

Marija Zima-Brockarjova
ABB Electrification
Zurich, Switzerland

marija.zima@ch.abb.com

HOW BETTER DECISIONS ARE OPTIMIZING DATA CENTER ENERGY EFFICIENCY

Power down

Driven by society's relentless demand for information, data centers now consume about one percent of the world's energy. Nevertheless, in spite of the rapidly growing amount of data they process, data center energy demand has remained almost flat for years.

Aleksandar Grbic
ABB Electrification-Smart Power
Quartino, Switzerland

aleksandar.grbic@ch.abb.com

Over the past decade, ABB has pioneered the automation systems that have been making data centers increasingly energy efficient. Now, with the introduction of ABB Ability™ Energy and Asset Manager, this trend has been taken to a new level.

ABB Ability™ Energy and Asset Manager accomplishes this by consolidating all relevant data center information and exploiting the advanced measurement, monitoring and analysis capabilities offered by ABB devices, such as circuit breakers, transfer switches, temperature modules and UPSs. It also allows easy configuration of related software, hardware, and communications systems.

Moreover, the ABB Ability™ Energy and Asset Manager platform allows the monitoring and accurate measurement of data center power usage effectiveness – the most critical energy metric for operators. Available as a local or cloud-based system, the platform assists data center professionals in making the best use of their valuable time. For instance, since all the relevant data on power consumption, performance metrics, and status is managed in real time by one system, the system supports optimized predictions and decisions regarding when maintenance should be performed.

Taken together, these capabilities add up to a platform for advanced energy optimization that can save up to 20 percent on energy bills, 30 percent on operational costs, 40 percent on maintenance, and 100 percent on unplanned labor.

With data center renovation now an important market factor, it is good to know that ABB Ability™ Energy and Asset Manager can form the basis for a site upgrade. But whether installed in a new data center or as a retrofit, ABB Ability™ Energy and Asset Manager represents the best way forward in ensuring data center sustainability.

Three varieties of Ability™ Energy and Asset Manager are available: Essential, Enhanced and Advanced; these allow operators to choose the level of sophistication their energy and asset management requires. •

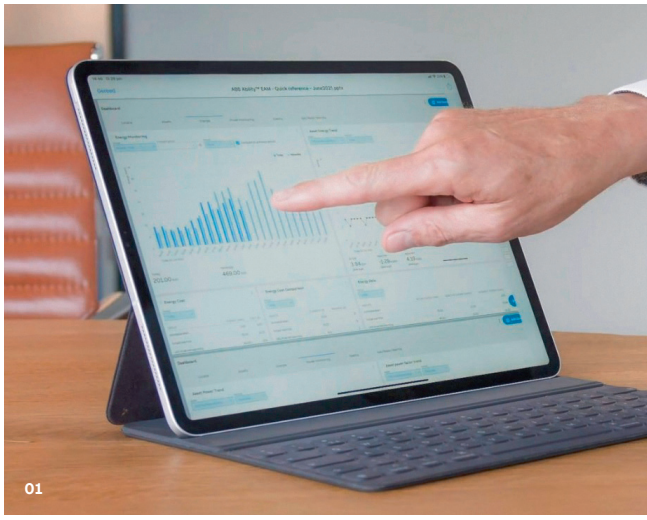
— The ABB Ability™ Energy and Asset Manager platform makes it possible to monitor and measure power usage effectiveness.

Further information:
ABB. Data center energy efficiency and management. Available at: https://search.abb.com/library/Download.aspx?DocumentID=1SDC007258G0201&LanguageCode=en&DocumentPartId=&Action=Launch. Accessed: November 25, 2021

HEADING FOR ENERGY NEUTRALITY

Balanced buildings

Just south of the ancient city of Utrecht in the Netherlands is one of the world's newest high-efficiency buildings. It is the home of Verweij Elektrotechniek, an established electrotechnical company that has created a new state-of-the-art smart office building.


01


02

—
01 The building's energy platform provides insights into potential savings.

—
02 Data generated by the building's systems helps optimize its energy use.

The company's 70 employees use 3-D building information models (BIM) to generate building plans for their customers – just as they have for their own building.

Loaded with networked sensors and actuators, the building responds automatically to a range of changing conditions. For instance, the lighting above workstations adjusts its color according to the location of the sun. Lights are activated by motion sensors; but if no one is in an area, even the green emergency exit signs switch off.

—

Verweij Elektrotechniek's building is virtually energy neutral in the context of the surrounding community.

Of course, in addition to maximizing the comfort and productivity of its users, saving energy is what the building is all about. Equipped with the ABB Ability™ Energy and Asset management platform, the building not only generates much of its own energy by means of a heat pump combined with a photovoltaic system but monitors and balances this with demand – including EV charging. This load balancing ensures that systems operate safely and that peak shaving takes place, meaning that the building is virtually energy neutral in the context of the surrounding community.

Furthermore, since all the building's energy-related systems are monitored around the clock, the resulting data is used to optimize maintenance and improve the accuracy of predictions.

The building's energy platform is brand-independent and provides clear insights into its energy flows. Furthermore, it presents data in a clear dashboard and compiles energy reports that help users zero in on potential savings. Data is securely stored in the cloud and can be accessed from anywhere. •

Ron van de Beek
ABB Electrification
Rotterdam, Netherlands

ron.beek@nl.abb.com

Powerful connections

76

76

The importance of connections cannot be overstated, whether physically powering and linking devices or providing them with the data and transparency that help them work smarter, which makes them both enablers and multipliers. ABB continues to innovate ways to make connections better, safer, and more reliable.

75

LUG LINK BINDS CUSTOMER'S POWER CONNECTION

Sealing the deal

Generator sales have seen a significant increase due to rising demand for uninterruptible and reliable power supply systems from end-users and increased demand for IT infrastructure management [1].

Ralph Donati
ABB Electrification Installation Products
Memphis, USA

ralph.donati@us.abb.com

When Wedlake, a Tulsa, Oklahoma-based company that offers a full line of industrial generator-related products, had only 48 hours to complete an important project for generator enclosures, the company's team reached out to their distributor partner to help find a solution. ABB was consulted and selected to provide the needed compatible lugs and specialty application tooling to securely complete a number of power connections.

ABB and its channel partners worked quickly to provide what was needed. This started with using the Lug Link Color-Keyed® Selector app for accurate size verification, as well as for technical data related to this application. They were also able to leverage ABB's Tool Services loaner program, which overnighted a range-taking battery-powered SMART® tool to ensure proper crimps and connectivity. Collaborating across the

ABB and its partners worked quickly to provide what was needed.

ABB business, from customer service and field technical experts to warehouse and inventory specialists, they were able to source, route and ship the Color-Keyed® lugs in time to meet the customer's deadline. •

ABB provided compatible lugs and specialty application tooling.

Reference

[1] Cision. Worldwide generator sales. Available: https://www.prnewswire.com/news-releases/the-worldwide-generator-sales-industry-is-expected-to-reach-26-5-billion-in-2026-at-a-cagr-of-5-9-from-2021--301292787.html [Accessed January 18, 2022].

SWITCHGEAR THAT INSTALLS IN A FLASH

Breaking the mold

Electric utilities are constantly searching for ways to reduce or eliminate the need for maintenance, while preserving or even upgrading the functionality of electrical equipment on their systems.

— Elastimold™ switchgear proved to be exactly what Greystone needed.

GreyStone Power Corporation, a large electrical cooperative near Atlanta, Georgia, was seeking an “oil-less” retrofit solution for its oil-insulated switchgear installed base to alleviate concerns of potential leaks, maintenance costs, and downtime inherent to owning oil-insulated pad-mounted switchgear. In addition, GreyStone was looking for a switchgear solution that would be easy to retrofit in the field with a minimum amount of labor. To accommodate this, the retrofit solution needed to fit onto the existing pad, have matching phase rotation, and eliminate the need to splice or pull in new cable.

Elastimold™ switchgear, which is available from ABB, proved to be exactly what GreyStone needed. A completely solid dielectric line of switchgear, Elastimold has two main components that are the core of its product offering – a molded vacuum switch (MVS) and a molded vacuum interrupter (MVI). Both devices are available with user-specified IEEE 386 underground interfaces such as 200A load break bushing wells and/or 600A dead break bushings.

Switchgear configurations typically use MVSs with 600A on the source side for load switching. MVIs are more common on the load ways for fault interrupting and sectionalizing. Using the modularity and operational flexibility of MVSs and MVIs, ABB’s engineers were able to develop a custom retrofit switchgear for GreyStone. Due to the small and compact nature of its MVSs and MVIs, Elastimold switchgear typically has a smaller overall footprint compared to other switchgear with different insulation technologies. However, for this project, the Elastimold design used a larger than standard cabinet to match the same dimensions as the original switchgear, allowing it to be placed onto the existing pad. Using a cable bus, the Elastimold™ retrofit switchgear was able to replicate the original switchgear’s phase rotation of ABC-CBA.

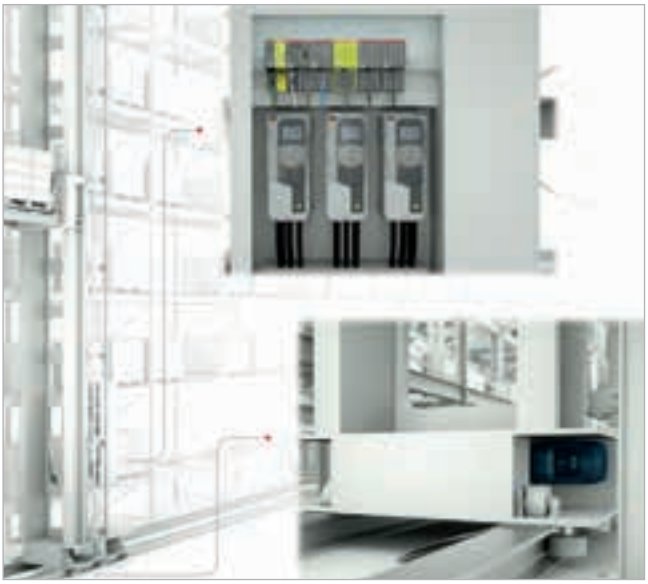
Elastimold solid-dielectric molded vacuum switches, interrupters and switchgear are now available with the Tru-Break™ switchgear module that makes it easy for linemen to switch the handle to the open position and visually verify the isolating gap in the conducting path. The small window in its design has contributed to safer installation. Knowing with certainty that the circuit is open, linemen can safely ground a line and perform maintenance on a de-energized, isolated and grounded circuit.

— ABB’s engineers were able to develop a custom retrofit switchgear for Greystone.

The product’s modular design offers the important advantage of enabling an economical retrofit of the Tru-Break switchgear module to previously installed Elastimold single-phase and three-phase switchgear. It took GreyStone approximately 2 hours for a complete retrofit rather than an estimated 8 hours from their experience with a non-custom “oil-less” solution. •

Ralph Donati
ABB Electrification Installation Products
Memphis, USA

ralph.donati@us.abb.com



01

02

Title photo: ©VanderWolf Images/stock.adobe.com

ABB PLCS AND DRIVES IMPROVE SAFETY AND PRODUCTIVITY

Safe working with machines

Fully automated and autonomous machines require safety PLCs not only for simple safety functions such as emergency stop, but also for complex ones like collision prevention, safe positioning for load/unload operations, etc. ABB's AC500-S safety PLC combines with the AC500 PLC to provide such functionality.

Yauheni Veryha
ABB AG
Heidelberg, Germany

yauheni.veryha@de.abb.com

The standard PLC is a familiar and essential component in most automation settings. When functional safety is of particular concern, a special type of PLC is deployed: the safety PLC. A safety PLC can be integrated with a standard PLC. Integrated safety PLCs perform safety functions that control machines and processes in a highly deterministic manner. These PLCs constantly protect against failures in plants that could harm people or equipment or cause environmental damage. If incipient hazards are detected, the safety PLC puts the appropriate equipment into a safe state.

> A well-conceived safety system will allow an enterprise to improve productivity, reduce downtime and optimize costs.

Advantages of functional safety systems
Beneficiaries of functional safety systems are, for instance, material-handling operations, such as distribution warehouses, cranes, industrial lifts and mine hoists, collaborative robots and mobile robot platforms, and scenarios where automated guided vehicles (AGVs) are used.

A well-conceived safety system will allow an enterprise to improve productivity, reduce downtime and optimize costs. The standardized, comprehensive and integrated safety systems provided by ABB also cut automation solution development time and allow the establishment of an environmentally friendly operation. The ABB AC500-S safety PLC lies at the heart of ABB's industrial safety controller philosophy [1].

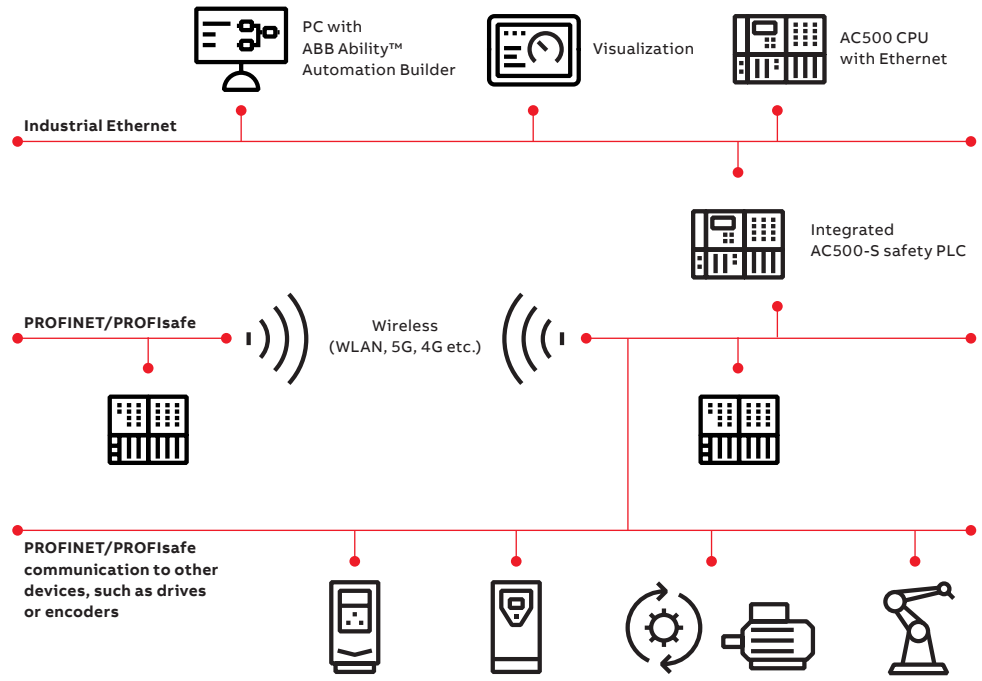
The ABB AC500-S safety PLC
ABB's AC500 controller family is found in many industries. The AC500-S is ABB's solution for situations where safety is of particular importance →01.

In addition to material-handling situations, the AC500-S is ideal for monitoring and controlling hydrogen filling stations →02, entertainment parks, wind turbines and many other applications.

The scalable AC500-S PLC is based on a modular design that incorporates a CPU, AC500-S functional safety, communication modules and I/O modules. The system can be easily expanded when required and includes advanced safety functionality, such as fail-safe condition monitoring, trigonometric functions and floating-point calculations.

—
01 ABB's AC500-S safety PLC is an essential component in situations where failsafe systems are vital, such as in the distribution center shown here.

—
02 AC500-S safety PLCs in hydrogen filling stations help reduce fueling time.



03

—
ABB's PLC YouTube channel

The standard AC500 with an integrated AC500-S safety PLC benefits from high-performance CPUs and facilities such as IEC 61131 programming editors, object-oriented programming, multi-user engineering, versioning, a virtual controller, etc. These features improve system flexibility and thus make engineering simpler. The PLC supports communications over PROFINET, EtherCAT, OPC UA, Ethernet/IP, CANopen, CAN J1939, BACnet, etc. and these can be configured in a few simple steps.

The AC500-S is realized as 1oo2 (one-out-of-two) system (in both safety CPU and safety I/O modules). A 1oo2 system includes two microprocessors, each of which executes the safety logic in its own memory area. The results are then compared. If a mismatch in the execution or an error is detected, the system goes to a safe state, which is described for each of the safety modules separately.

The integrated AC500-S safety PLC achieves a safety integrity level (SIL) of up to SIL 3 (IEC 62061 and IEC 61511) and complies with ISO 13849-1 Performance Level (PL) e (the highest of five levels). To qualify as approved to SIL 3 – a rigorous standard that includes resilience against corrupt software injection – a safety PLC must detect over 99 percent of potential failures.

PROFIsafe

The AC500-S makes use of multiple controller to controller communications via PROFINET/PROFIsafe. PROFIsafe enables functionally safe communication between a safe controller and safe end-devices (eg, emergency stop buttons or drives with safety functions). PROFIsafe is a software layer that sits on top of PROFINET to provide functional safety in PROFINET or PROFIBUS networks →03.

—

The system can be easily expanded when required and includes advanced safety functionality.

A recent development is that the AC500-S supports PROFIsafe V2.6 (all data types) and long frames (up to 123 bytes of safety data in one frame) for data exchange. PROFIsafe long frames allow the exchange of large amounts of fail-safe data in addition to small frames (up to 13 bytes of safety data in one frame). This advance represents an addition to existing controller-to-controller communication and shortens safety CPU cycle time due to fewer PROFIsafe instances in the safety program for failsafe data exchange. In the future, OPC UA Safety will be supported in addition to PROFIsafe →04. OPC UA Safety is an independent standard for safe communication

—
03 A typical modular, scalable and reliable PROFINET/PROFIsafe and AC500 setup with advanced functional safety.

—
04 PROFIsafe and OPC UA Safety are key elements for interoperability and smart safety solutions.

between controllers, especially those made by different manufacturers. PROFIsafe long frames and OPC UA Safety are of particular advantage to modular machines, AGVs →05, 06, autonomous moving robots (AMRs) or tool changers.

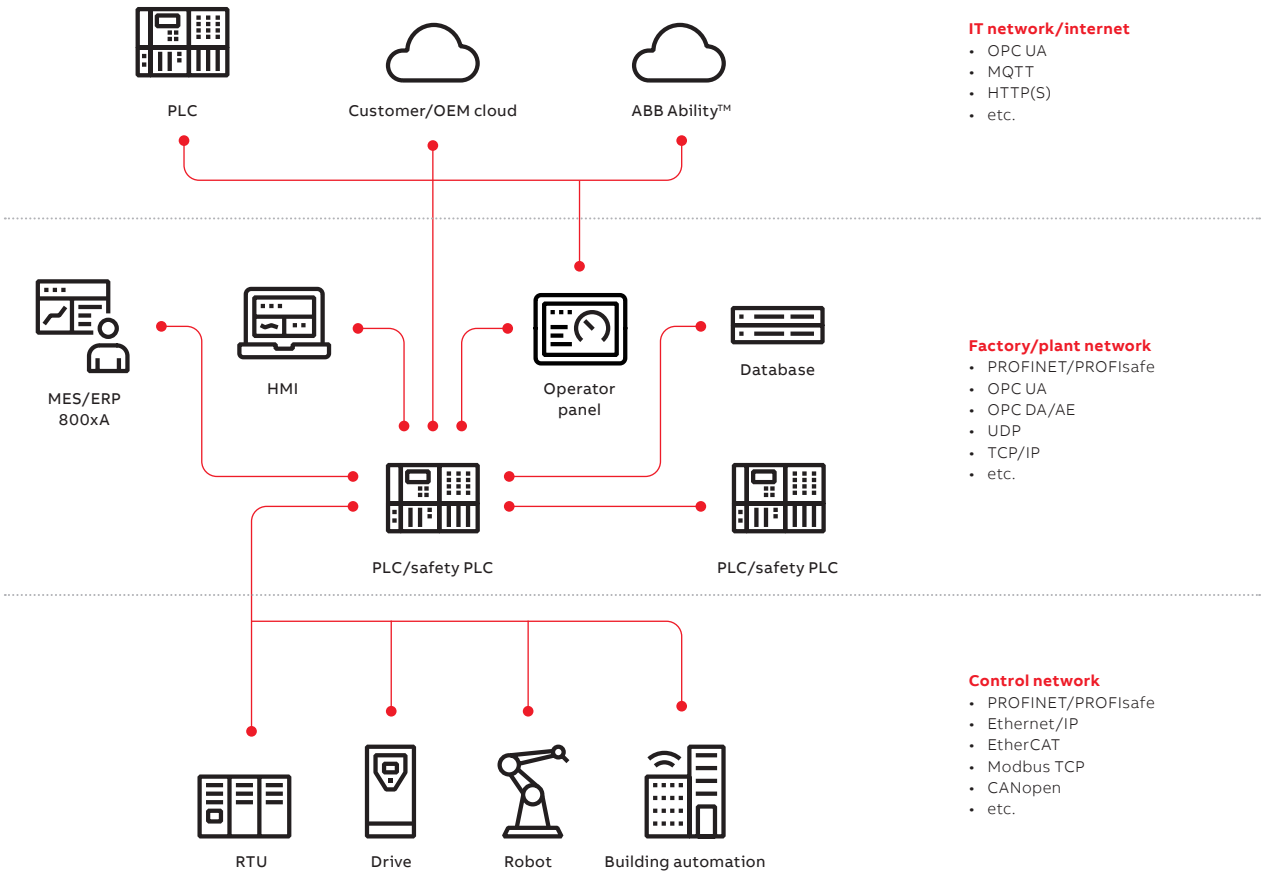
ABB Ability™ Automation Builder
Interconnectivity such as that shown in →03 is supported by one common engineering platform – Automation Builder. Automation Builder is an integrated software suite for machine builders and system integrators to automate their machines and systems in a productive way. Combining the tools required for configuring, programming, debugging and maintaining automation projects, Automation Builder addresses the most significant single cost element of most of today's industrial automation projects: time spent working with software.

The many advantages of 5G can be leveraged to allow real-time PROFINET communication with mobile machines.

A project using wireless connectivity with 5G is shown in →06. The many advantages of 5G, such as fast reaction times and high device density, can be leveraged to allow real-time PROFINET communication with mobile machines.

PROFINET names and PROFIsafe addresses on the machine and operator levels in →06 can be changed using hardware address switches on PLC modules. Thus, the same PLC boot project can be used for similar machines and operator control setups, significantly reducing development and maintenance engineering effort.

ABB drives offer integrated safety
The flexibility and capability of the AC500-S are reinforced by industrial drives, general-purpose drives and machinery drives that can be fitted with optional safety function modules that achieve up to SIL 3 / PL e. These modules make PROFIsafe communication between the drive and the AC500-S possible via PROFINET. All drives have hardwired Safe Torque Off (STO) built-in as standard.

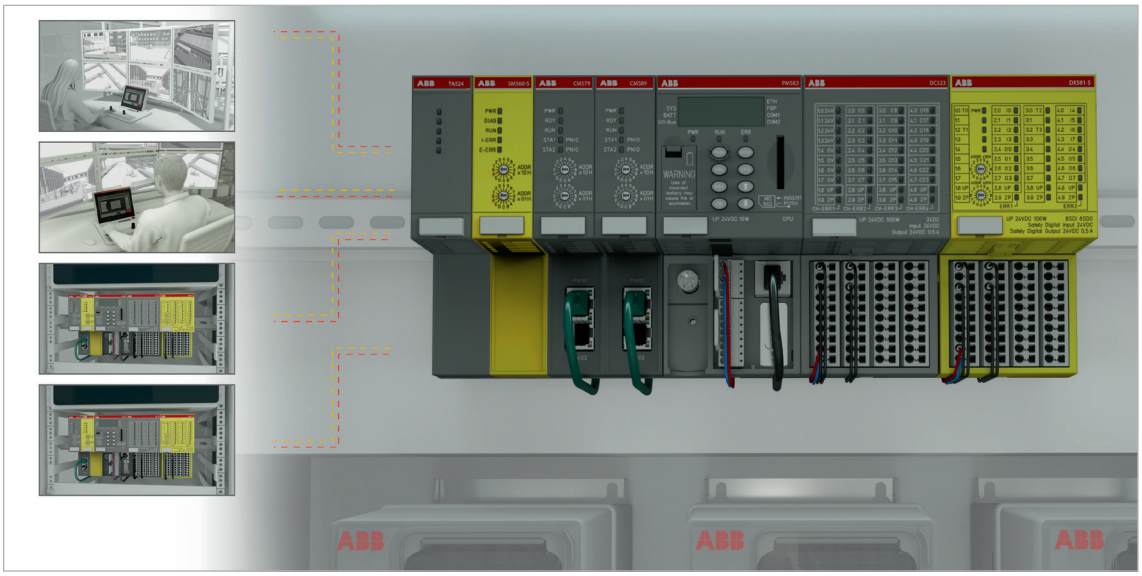


The FSPS-21 PROFIsafe safety functions module, for instance, is ideal for applications where only STO or Safe Stop 1 Time Controlled (SS1-t) safety functions are required. The FSPS-21 removes the need for cabling for hardwired STO as the functionality can be requested from the AC500-S over PROFIsafe. Setting up the FSPS-21 is simple due to the functionality of the module (only STO and SS1-t functions are available).

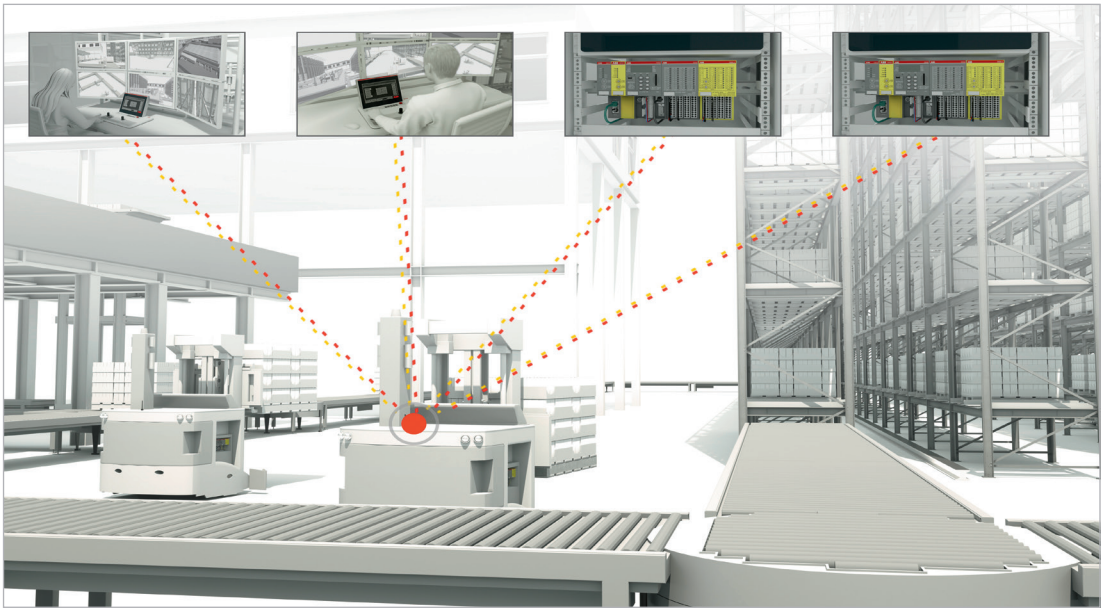
The FSO-12 safety functions module enables speed-based safety functions like Safely Limited Speed (SLS), including variable SLS, Safe Maximum Speed (SMS) and Safe Stop 1 Ramp Monitored (SS1-r). Additionally, the FSO-12 module reports the failsafe speed value over PROFIsafe

The AC500-S safety PLC fulfills the highest performance requirements.

for use in the AC500-S safety program. The FSO-12 safety functionality is implemented without the need to attach an external encoder for applications without external active loads (eg, hanging loads). For hanging loads – for instance, in hoisting operations – FSO-21 and FSE-31 modules, together with a safety encoder, are required.



05



06

07

08

— 05 If an unexpected situation arises, the operator can step in and take fail-safe control of the AGV using PROFINET/PROFIsafe communication.

— 06 Project example with 1 x 4 wireless connectivity using PROFINET/PROFIsafe.

— 07 Safety is paramount in situations where people and AGVs mingle.

— 08 With increasing automation of freight handling, safe communications are vital.

Safer, greener and more productive with the AC500-S

The AC500-S safety PLC fulfills the highest performance requirements in machinery and process safety and delivers quality and conformity with TÜV-certified components and tools.

With its advanced functional safety solutions for safe position detection (eg, for collision avoidance) and variable safely limited speed, acceleration, deceleration, etc., the PLC keeps the process running at optimal speed instead of stopping or slowing it and opens the door to significant throughput and productivity improvements.

The AC500-S enables safe communication between machines, AGVs and other objects – such as gates, robots, or electrical charging equipment – in shared working areas and thus reduces downtimes →07 – 08. The PLC's safe remote control ability – coupled with a safety human-machine interface (HMI) and advanced security properties – is convenient for renewable installations, for instance, as many of these are in remote locations.

With a design that is flexible, modular and scalable, development times are short and the AC500 can be quickly configured or dynamically adapted to new production demands, such as a change in the number of machines. Teamed with PROFINET/PROFIsafe communications, the comprehensive capabilities of the ABB AC500-S safety PLC provide operators with the best tool to reduce automation solution development time, maximize productivity and optimize costs. •

— The AC500 can be quickly configured or dynamically adapted to new production demands.

— **References**

[1] ABB, "Safer, greener and more productive with AC500-S safety PLC." Available: https://new.abb.com/plc/plc-technology/ac500-plc-applications/safer-greener-and-more-productive-with-ac500-s-safety-plc [Accessed February 16, 2022].

BUZZWORD DEMYSTIFIER

Circularity

With the effects of climate change visible across the world, and with increasing pressure on natural resources, industries and governments are swiftly adopting measures to lower their impact on the environment. In the midst of these ambitious sustainability goals, the concept of "circularity" is gaining in popularity. Indeed, circularity has now emerged as one of the fundamental building blocks of a sustainable society.

James Macaulay
ABB Corporate Communications
Vancouver, Canada

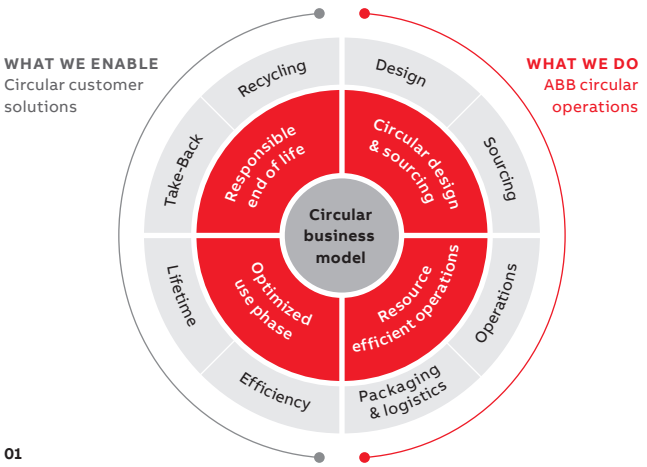
james.macaulay@ca.abb.com

Every year, humans extract around 100 billion tons of natural resources from the Earth [1], including biomass, fossil fuels, metals and minerals. This figure is rising rapidly in parallel with global population growth and urbanization and is on a trajectory to double by 2060 unless we make major changes to our economies. Global waste generation is now doubling at twice the rate of population growth [2]. Less than 10 percent of resources are recycled, reused or composted, while resource extraction, processing and consumption account for roughly 70 percent of all greenhouse gas emissions.

By contrast, circularity is an approach that would allow us to live more within our planet's means. Instead of a linear "take-make-waste" model of production and consumption, circularity aims to keep resources in use by "designing out" waste and pollution, keeping products and materials in use and regenerating natural systems. Much like nature's biological cycle, in a circular economy, products can re-enter the ecosystem (ie, to be used as raw materials). This ensures that nothing is wasted, and every resource is used to

—

Organizations can ensure products are designed so they can be reused, remanufactured, or repaired.



its full value. By adopting circularity strategies, organizations can ensure Earth's resources are efficiently used, and products are designed in a way so they can be reused, remanufactured, or repaired, keeping them in circulation so they don't contribute to landfilling.

Going well beyond traditional recycling, circularity also focuses on durability and reusability across value chains and industries. In a circular economy, the whole lifecycle of the product is taken into consideration, including upstream from its manufacture, to design it in a way so that it is likely it will be reused or repurposed. For instance, following the circularity approach, thousands of ABB industrial robots have been refurbished and upgraded to have a second life [3] →01.

Thousands of ABB industrial robots have been refurbished and upgraded to have a second life.

Products are also designed to be used for extended periods by providing effective maintenance. This is made possible by Industry 4.0 advances, where data from connected devices is collected and analyzed to produce information for operators that can help them monitor and optimize the performance of their equipment. The Industrial Internet of Things (IIoT) supports need-based maintenance, potentially avoiding any unexpected failures while increasing productivity and extending asset lifespans. By helping businesses use resources efficiently, technology is helping to make the circular economy a reality. •

01 ABB's circularity model.

References

[1] Circularity Gap Report 2020, de Wit, M., Hoogzaad, J., von Daniels, C., CGRi, 2020, https://www.circularity-gap.world/2020 [Accessed March 31st, 2022].

[2] Kaza, S., Yao, L., Bhada-Tata, P., Van Woerden, F. et al, What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, World Bank Group. Washington, DC, 2018, https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html [Accessed March 31st, 2022].

[3] ABB makes manufacturing more sustainable by recycling and remanufacturing thousands of old robots, ABB news release, ABB Group, Zurich, 2020, https://new.abb.com/news/detail/64305/remanufacturing-old-robots [Accessed March 31st, 2022].

SUBSCRIBE

How to subscribe
For a subscription, please contact your nearest ABB representative or subscribe online at www.abb.com/abbreview

In continuous publication since 1914, ABB Review is published four times a year in English, French, German, Spanish, and Chinese. ABB Review is free of charge to those with an interest in ABB's technology and objectives.

Stay informed...
Have you ever missed a copy of ABB Review? Sign up for the e-mail alert at abb.com/abbreview and never miss another edition.

Please note that when you register for this alert, you will receive an e-mail with a confirmation link. Please ensure that you have confirmed your registration.

IMPRINT

Editorial Board

Theodor Swedjemark
Chief Communications & Sustainability Officer and Member of the Group Executive Committee

Bernhard Eschermann
Chief Technology Officer, ABB Process Automation

Amina Hamidi
Global Product Group Manager Division Measurement & Analytics ABB Process Automation.

Daniel Smith
Head of Media Relations

Adrienne Williams
Senior Sustainability Advisor

Reiner Schoenrock
Technology and Innovation

Andreas Moglestue
Chief Editor, ABB Review
andreas.moglestue@ch.abb.com

Publisher
ABB Review is published by the ABB Group.

ABB Ltd.
ABB Review
Affolternstrasse 44
CH-8050 Zürich
Switzerland
abb.review@ch.abb.com

Partial reprints or reproductions are permitted subject to full acknowledgement. Complete reprints require the publisher's written consent.

Publisher and copyright ©2022 ABB Ltd.
Zürich/Switzerland

Printer
Vorarlberger Verlagsanstalt GmbH
6850 Dornbirn/Austria

Layout
Publik. Agentur für Kommunikation GmbH
Ludwigshafen/Germany

Artwork
Indicia Worldwide
London/United Kingdom

Disclaimer
The information contained herein reflects the views of the authors and is for informational purposes only. Readers should not act upon the information contained herein without seeking professional advice. We make publications available with the understanding that the authors are not rendering technical or other professional advice or opinions on specific facts or matters and assume no liability whatsoever in connection with their use.

The companies of the ABB Group do not make any warranty or guarantee, or promise, expressed or implied, concerning the content or accuracy of the views expressed herein.

2/2022 is the 897th issue/volume 109 of ABB Review.

ISSN: 1013-3119

abb.com/abbreview

Affix address label here

Welcome, everyone.

We all have a contribution to make in building a sustainable future. See why at **go.abb/progress**

ABB